ENGINEERING NEWS

THE LEHIGH VALLEY RAILWAY SYSTEM seems likely to have an independent line to Buffalo some time in the near future. A recent report states that the managers contemplate building an independent line parallel to the Erie from Elmira to Buffalo. It is more likely, however, that the Buffalo & Geneva Railroad, a new charter for which was secured last week, will be the Lehigh Valley's outlet to Buffalo, where the company already has extensive terminals. The line is to run from Geneva, the northern terminus of the Geneva, Ithaca & Sayre Ry., to Buffalo, about 100 miles. Considerable work has been done on the surveys, but no route has yet been decided upon. The company is incorporated with a capital stock of $1,400,000, of which $150,000 is held by WILSON S. BISSELL, of Buffalo. This route would be a somewhat longer one from the Pennsylvania coal fields to Buffalo than the Erie line; but to offset this, it is claimed, we believe, that the grades are on the whole more favorable.

WORK ON THE NICARAGUA CANAL is likely to be started this month by sending a dredging and pile-driving plant to Greytown to open the harbor for construction purposes for vessels of 15 to 18 ft. draft. To this end nothing more is required than to construct a short brush and pile pier to divert the shore current caused by the trade wind—which continually tends to move sand westwardly along the beach, and close up the harbor—and then to dredge a channel through the bar. The work of permanent improvement to 30 ft. draft of water will not be undertaken until a railway has been built some 17 miles inland to the great divide rock cut, and work on it has so far advanced as to furnish adequate rock spoil for the construction of the permanent pier or breakwater. Offers have been received already from bankers for the entire proposed issue of bonds on terms which cannot be called high, if not so good as is desired, and the prospect could hardly be better for the early beginning of active work on the canal proper; the first point of attack being necessarily the great divide rock cut, 3 miles long, containing about 8,000,000 cu. yds. of solid basalt rock, overlaid by 2 to 20 ft. of earth.

THE MANCHESTER SHIP CANAL, according to the recently issued half-yearly report, employs 9,985 men, 827 boys, 207 horses, 141 locomotives, 4,398 wagons, 80 steam navvies, 83 steam cranes, and 170 pumping and other engines, with 180 miles of railway. The company has already paid $3,887,570 for 3,734 acres of land, though the amount originally claimed for this land was $7,552,685. Since Feb. 11, the date of the report, over 1,000 men have been added to the working force, and the contractor says he will have 20,000 men at work in the coming summer. In this connection it may be said that the Mersey Dock and Harbor Board is very actively seeking legislation which is prejudicial to the interests of traders on the upper Mersey, and the latter are as actively combating these clauses.

THE HUDSON TUNNEL RAILWAY CO., of New York, have lately offered in London an issue of $1,500,000 first mortgage 6 per cent. bonds to be used for the construction of the tunnel under the Hudson river. This is the first part of an authorized issue of $2,750,000 bonded capital, which is to be expended under Sir JOHN FOWLER and Mr. BENJAMIN BAKER as engineers. The lengthy prospectus gives a very roseate view of "the magnitude of the local traffic" between New York and Jersey City that is to be turned into this tunnel when completed.

THE WASHINGTON AQUEDUCT REPORT and the recommendations of the Congressional Committee are said to be creating intense dissatisfaction. It is claimed that the committee was against the tunnel from the start. The chief cause of grievance, however, is that if the recommendation to abandon the tunnel for a surface aqueduct is carried out, the District taxpayers will be saddled with a heavy expenditure for a work which was exclusively under the control of Congress and United States officials. They think the expense should be assumed by the general Government.

AN OHIO RIVER BRIDGE, at Brunot's Island near Pittsburg, Pa., has been let by Chief Engineer M. J. BECKER, of the Pittsburg, Cincinnati & St. Louis R. R. Co. It will be used when completed as a connecting line between the roads of the Pennsylvania Company, by which they can ship through freight around instead of through Pittsburg. The bridge will be a mile long and cost about $600,000.

BAGGAGE CHECKING AND HANDLING is so ably managed on the Pennsylvania Railroad system that in 1888 only three pieces of baggage out of 5,000,000 were lost.

THE MAIN ELECTRIC CAR, controlled by the River & Rail Electric Co., of this city, has recently had a successful test in Washington and is said to promise excellent service. The system uses only one motor instead of two, and the entire motive apparatus, storage batteries and all, weighs only some 4,000 lbs., it is stated, being much less than most other motors. The speed of the car was 8 to 12 miles per hour. The mechanical connection between the motor and the sprocket-wheel driving chains is exceedingly ingenious, novel, and compact. The motor is not stopped because the car is stopped, but continues in motion unless the stop is to be of some duration, and a change can also be made from high speed and low power to low speed and high power without any change in the motion of the motor. The storage batteries likewise are claimed to be a great advance on past practice, especially in respect to durability.

THE CITY SURVEYORS OF OMAHA, according to a late city ordinance, must take out a license at a cost of $50 per year. Without such a license no surveyor can practice in that city. The application must be in writing and must be accompanied by a certificate of the city engineer and county surveyor testifying that the applicant is a competent and skilful surveyor and a suitable and reliable person to do work of this nature in Omaha, and it must be also accompanied by a bond of $5,000 conditioned upon the skilful, honest, and faithful performance of his duty as a surveyor.

THE ARTESIAN WELL BASIN OF DAKOTA, according to a correspondent of the *Pioneer Press*, supplies abundant water under a pressure of "140 lbs. to the sq. in." from wells 1,165 ft. deep. The uniform temperature of the water is 70° F., and the pressure quoted is now obtained from a 4-in. well at Ellendale, Dickey Co., Dakota.

BITUMEN PAVING BRICKS are to be manufactured on a large scale by a company now erecting works at the bitumen mines at San Luis Obispo. Improved machinery is to be used, says the Los Angeles *Herald*.

THE ANTOFAGASTA (CHILI) & BOLIVIA RAILWAY Co. has been incorporated in England, to acquire from the Huanchaca Co., of Bolivia, the concessions granted by the Governments of Chili and Bolivia for a line from Antofagasta in Chili to Huanchaca in Bolivia. The Huanchaca Co. has already constructed and opened for traffic the whole of the Chilian line, 272.8 in length, up to the frontier. Considerable progress has been made with the Bolivian line, about 130.2 miles in length. The railway having been made over the Andes, no engineering difficulties exist to prevent its steady completion to Huanchaca. The Huanchaca Co. has undertaken to complete the railway to this point within two years, for a fixed inclusive amount of $1,500,000. Arrangements have been made with the Huanchaca Co. for the survey of a further extension to Oruro, which is authorized by the concession. The concession includes the privilege of establishing waterworks at Antofagasta, the supply being taken from the Loa river and conveyed by a system of aqueducts 194.68 miles long. The company has a capital stock of $7,250,000. Messrs. JAMES LIVESEY & SON are the engineers.

A LARTIGUE SINGLE-RAIL RAILWAY is to be built in the Argentine Republic from Chilecito to the mineral mountain of Famatina, and the surveys have been made and submitted to Government. The cost of this mountain line being rather higher than originally contemplated, the concessionnaires have petitioned for an increase of the subsidy, and the Government will support this demand at the next meeting of Congress. The cost of this line, about 81 miles long, will be about $2,500,000 gold, and it will go to about 14,000 ft. above the level of the sea. It will have about 130 bridges and some long tunnels. A railway on this system is in operation in Ireland.

THE "WHITE STAR" STEAMSHIPS, *Teutonic* and *Majestic*, now under construction, will be 582 ft. long, 56½ ft. wide, and 39 ft. 4 in. deep, with a gross tonnage of about 10,000 tons. They are built of Siemens-Martin steel and have triple expansion engines driving twin propellers. They are designed to be converted into war-ships in an emergency, and they are so fitted during construction that twelve heavy guns can be mounted on each ship in 48 hours.

THE CHINA RAILWAY CO., says the London *Railway News*, has been ordered to push its line within 12 miles of Pekin, notwithstanding the late reported edict against such extension as the result of the astute opinion of the Imperial astrologers regarding the consequences of such extension. The present edict means 60 miles more of railway towards Pekin, and another 5-mile extension eastward to Kaiping.

A NEW TUNNEL on the Evansville & Richmond Ry. near Bedford, Ind., 900 ft. long, is to be made immediately. The contract has been let to Mr. R. P. MCCORMICK, of Kansas City.

Mr. S. V. RYLAND, one of the contractors for the erection of the Hawkesbury Bridge, New South Wales, was *not* killed by a shark in December last, as has been extensively reported in the daily press. This denial comes from the Union Bridge Co., of this city, the employers of Mr. RYLAND.

THROUGH TRAINS between New York City and Washington are to begin running March 10, over the Central Railroad of New Jersey, Philadelphia & Reading, and Baltimore & Ohio lines. Five express trains, with Pullman cars attached, are to run each way daily. With slight changes in connecting tracks, which will obviate delays in the connection between the Reading and the Baltimore & Ohio roads at Philadelphia, it is believed that as fast time can be made as is now made by the Pennsylvania. So long as the old depots were in use at New York and Philadelphia, these lines could not expect to attract a very heavy passenger traffic. But with the new Jersey city depot of the Central of New Jersey road and the new Baltimore & Ohio depot in Philadephia to accommodate the traveling public, the new line ought to receive a large patronage. The schedule time, according to Mr. J. VAN SMITH, Supt. of the Philadelphia division of the Baltimore & Ohio, is to be 5½ hours, which is considerably better than the present Pennsylvania schedule.

THE FIGHT OVER GRADE CROSSINGS in Connecticut seems ended. The Supreme Court of the State has decided in favor of the constitutionality of the law which authorizes a portion of the expense for removing grade crossings to be assessed by the Railroad Commissioners upon the town in which the crossing at grade is removed. The decision is made in the case of the town of Westbrook against the Consolidated road. In 1887 orders were issued by the Commissioners for the removal of grade crossings. The case was carried by the town to the Superior Court, which issued a decree substantially affirming the order of the Railroad Commissioners. Appeal was made to the Supreme Court which has now decided in support of the rulings of the lower court. The court says:

> It will be impossible to construe the statute as prohibiting the assessment of any portion of the expense upon the town. Some of the highways may have been laid out after the construction of the railroads, and so in a sense the town may be said to have created the crossings. The railroad did, in fact, benefit the town. It increased the value of real estate, increased population and business, and the result was an increased grand list. These and like considerations induced the Legislature to require towns to bear some portion of the expense of abolishing grade crossings. The act is an exercise of the police power of the State. Its object is to change or remove certain conditions, lawful in themselves, but which have become a source of danger to life and property.

THE BURYING OF ELECTRIC WIRES is to be hastened in Pennsylvania by a bill now before the Senate of that State prohibiting all suspended electric wires in cities of more than 30,000 inhabitants. The bill is intended to go into effect after Aug. 1, 1889, and a penalty of $500 per day is prescribed for all violations of the provisions of the bill.

THE BURIAL OF WIRES, we are glad to see, is being vigorously pushed by the Mayor of New York. At the meeting of the Board of Electrical Control last week Mayor GRANT again read the riot act to the electrical companies, and went so far as to threaten certain poles with the axe if something was not speedily done in the way of actually putting wires into the conduits. The Metropolitan Co. said it had put 90 per cent. of its mileage underground at an expense of $147,000. The United States Electric Lighting Co. continues to assert that the subway system will not work, but promised to make a test as soon as it can get the cable. The Western Union Co. failed to report, and the Mayor directed it to take down its Broadway poles within 20 days, or he would act in the matter. Mr. ECKERT protested against the short time allowed. The Manhattan Co. wanted permits for 25 poles on First Avenue; permission was granted provided that poles be taken down elsewhere. There has been too much talk in the past from both parties to the controversy, and it is refreshing to at last see a chance for one of two things, either an actual burial of the wires and a removal of the poles, or a practical test that will compel the conduit contractors to substitute some more perfect system at their own cost, if the present conduits actually prove to be as worthless as some folks would have us believe.

THE PENNSYLVANIA has just erected the twentieth interlocking signal tower on the New York division at Mill Haven Jc., Pa. The tower has a 36 lever machine.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision March 1, on the Baltimore & Ohio, near Wheeling, W. Va. The trains, one a passenger and the other a freight, came together at a point where the track runs along a narrow shelf cut in the face of a high and very steep hill, about 100 ft. above the river. About 60 ft. below the Baltimore & Ohio tracks is the track of the Ohio River road, built on a high trestle, as the large rocks afford no room for a roadbed. The No. 4 passenger train, east-bound, left Benwood Junction with empty cars, and at the Narrows was making about 30 miles an hour. Through a misunderstanding of orders, freight No. 89, west-bound, left Moundsville for Wheeling on the passenger train's time, and was making about 20 miles an hour as it rounded the sharp curve at the south end of the Narrows. Two freight cars fell over on the Ohio River trestle, blocking that road. No lives were lost.——A rear collision occurred at Paris, Ont., on the Grand Trunk, between a local passenger train and a way freight train which was standing at the depot. Two persons were killed. The driver of the local, in his statement, said that "the semaphore was down' and that he had been told "not to mind the semaphore."

BRIDGE ACCIDENTS are reported as follows: The false-works of the new bridge being built across the Potomac river at Point of Rocks, Md., were swept away recently by a freshet.——In Abbeville county, S. C., 13 highway bridges, probably for the most part rough and small ones, have been washed away or damaged by floods.

THE PANAMA CANAL may yet be completed, suggested an enthusiastic shareholder at the last meeting of the company in Paris, by volunteers "who would complete the work at the cost of bare maintenance." This suggestion is so very French that it is difficult to decide whether it was a serious proposal or an ill-timed jest. The suggestion suggests a big chance for shovellers.

THE NEW AGRICULTURAL DEPARTMENT, it is said, is to become a kind of scientific department, a Bureau of Ethnology, Philology, and what not, being attached to it. Such scientific bureaus would have a certain appropriateness in a Department of Public Works, but it is somewhat absurd to attach them to the Agricultural Department. It is worthy of note that the French Cabinet consists of ten members, 8 of them being the same as our own, now that the Agricultural Department has been added, and the two others being a Minister of Public Works and a Minister of Commerce. For both of these officials we have work already existing, and in time the departments will be created.

THE INTERSTATE COMMERCE LAW as now amended requires three days' public notice before a reduction in rates can be made, provides severe penalties for underbilling in any form, and adds the penalty of imprisonment to the fine already provided for unlawful discrimination in the matter of rates. The provisions of the present act regarding the publications of rates are made to apply to joint through rates; and a change in procedure is made which will facilitate the collection of damages in case of overcharges by railway companies. The approval of the bill was one of the last acts of the outgoing administration.

It will be seen that several of the amendments recommended by the Interstate Commerce Commission were ignored, and the provision calling for the punishment of discrimination by imprisonment, it is almost needless to say, was not recommended or suggested by the Commission. It seems almost certain that this absurd and unjust provision can never be enforced. It is absolutely impossible to make rates so that a great number of people and many trade centers will not complain of discrimination. Therefore to make discrimination a felony is manifestly an unwise and unjust act and one of which only a demagogue would approve.

RAILWAY STOCKHOLDERS in New England are organizing, and propose to have a voice in the management of the Western railway systems in which they are interested. Messrs. FRANCIS B. COOLEY and DANIEL R. HOWE, prominent business men of Hartford, Conn., are receiving proxies from a large number of stockholders of the Chicago, Burlington & Quincy, Chicago & Northwestern, Chicago, Milwaukee & St. Paul, Chicago, Rock Island & Pacific and Illinois Central companies, and will attend the annual meetings of these corporations to represent these investors and demand that their interests be respected and that their property be honestly managed. These gentlemen are not likely to find as much to condemn in the management of these properties as the stockholders who give them their proxies expect. But the movement to have railway stockholders take a more lively interest in the management of their properties is to be highly commended.

IMMIGRATION is still falling off. It was 10,272 last January, in place of 13,239 in January, 1888. For 7 months it has been 212,585 against 236,845. Imports and exports are now both very heavy, 15 to 20 per cent. more than a year ago.

CANADIAN RAILWAY SUBSIDIES are to be very sparingly granted in future. At a recent caucus of the Conservative party, Premier Sir JOHN MACDONALD said that the watchword of the Government was economy, and the members need look for very few railway subsidies. He hoped therefore that they would not press the Government to grant them.

MASON AND DIXON'S LINE, between Pennsylvania and Delaware, has been an imaginary line for many years past, with its monuments obliterated. A bill is now before the Pennsylvania Legislature asking for a commission of 3 from that State to meet a similar commission from Delaware, whose duty it shall be "to examine, survey, and re-establish" the boundary line. It is expected that this resurvey will result in considerable shifting of land, as far as State location is concerned; and it is believed that it will also prove that a member of the Delaware Legislature is really a citizen of Pennsylvania.

THE ROSE POLYTECHNIC INSTITUTE of Terre Haute, Ind., which was founded by CHAUNCEY ROSE and opened in 1883, is devoted especially to the education of civil, mechanical, and electrical engineers. The institute has extensive workshops for machine construction, and has also a very complete equipment of electrical apparatus and instruments.

CANADA RAILWAYS, according to the report of J. H. POPE, Minister of Railways and Canals, for the year ending June 30, 1888, have a total extent of 12,332 miles. Of this total, 11,157 miles are laid with steel rails. The total capital invested is $683,773,000, and the gross earnings were $38,847,000, an increase of $5,500,000 over 1887. The net earnings were $11,217,000. Ten passengers were killed during the year, in every case from causes due to their own carelessness. The deficit on the Government roads was $454,000 greater than in 1887. The Intercolonial increased its gross earnings $316,000, but its operating expenses increased $448,000. During the year $1,374,000 was paid in subsidies to new railway lines.

THE MANCHESTER SHIP CANAL CO. was incorporated with a share capital of £8,000,000 and has authority to borrow £1,812,000, or a total authorized capital of £9,812,000 say, $49,060,000. By the Act of 1886 the company can pay interest out of capital during construction at the rate of 4 per cent. per annum, provided that this aggregate interest does not exceed $3,760,000. These 4 per cent. debentures are now being issued at par, and are repayable at par on Jan. 1, 1896; or they can be exchanged for perpetual mortgage debentures at 3½ per cent. at the option of the holder. The amount expended by the company to date is $8,000,000 on account of works and the construction is well up to time. The directors are confident that the whole work will be completed well within the contract time of Jan. 1, 1892.

Railways in Chili.

The following particulars are abstracted from the *Chilian Times*, of Santiago: On Jan. 4 the Senate passed the bill to empower the Government to purchase the plans of the railway from Calera to Ovalle, and to return to the concessionaire the sum of $100,000 deposited as security. On Jan. 7 a Standing Committee reported on the applications made by FERNANDO DÖLL, GEO. K. STEVENSON, and M. MARTINDALE for permission to build a railway from Antofagasta to Aguas Blancas; the committee recommended the rejection of all the applications, and presented a bill to empower the president to receive sealed proposals for the construction of the line. The same committee reported upon the applications of DON MIGUEL F. DEL FIERRO and Messrs. A. E. CARRANZA & Co. for permission to build a transandine line; the committee recommended the granting of a concession to CARRANZA & Co., the line to be of metre gauge, to start from Puquois station on the Copiapo line and to cross the Andes to join the Central Argentine road; they also recommended a guarantee of 4½ per cent. for 20 years on $3,000,000 (gold). Another application for permission to construct a transandine line via Copiapo, made by Mr. G. GROVE, remained to be reported on. On Jan. 7, 9, and 11, the petition of the representatives of the North & South American Construction Co. was under consideration, the debate being opened by the Minister of Public Works. The bill ratifying the contract with the company was passed finally in its original form in spite of the opposition. The degree of certainty with which the Government counted upon the passage of this bill was shown by the fact that while it was still pending in Congress, several of the works to be authorized were inaugurated by the president, and other works will now be inaugurated at once, among the first being the Calera and Ovalle line, a feeder to the State system, and the transandine line to connect with the State system at Los Andes. The paper states that, owing to delays, work will not be in full activity before next spring, as in three months (from January) the rainy season will commence. It was stated in the House of Deputies that the contract was the cheapest of its kind ever entered into in Chili, the price per kilometre, including equipment, under the modified contract with the company, being $28,000, of which one-third will be paid in gold and two thirds in paper. The cost in gold per kilometre, exclusive of equipment, for lines already constructed is given as follows:

Valparaiso to Quillota	$85,361
Quillota to Santiago	54,201
Santiago to San Fernando	37,313
San Fernando to Curico	27,028
Curico to Talca	28,754
Talca to Chillan and San Rosendo to Angol	28,070
Chillan to Talcahuano	26,436

The president formally inaugurated the Pelequen and Peumo, and Palmilla and Alcones branch lines on Jan. 6. The plans of the CLARK transandine line via Uspallata, from Andes station to the 10th kilometre, have been accepted by the Government. The Government has also approved the plans prepared by Mr. RICHARD DUFFY for the transandine line via Antuco Pass, the concessionaires for which are FRANCISCO BUSTAMENTE & Co. The Toco railway has received a consignment of steel rails. The Department of Public Works opened proposals on Feb. 4 for the Laja and Biobio railway bridges.

Proofs of Geometrical Theorem Published Jan. 26.

In ENGINEERING NEWS of Jan. 26, the following proposition was stated, to be proved by geometry :—

If equilateral triangles be erected on the sides of any triangle $A\,B\,C$, Fig. 1; and if the points X, Y, and Z, the centers of gravity of these equilateral triangles be joined by straight lines, these lines will form an equilateral triangle whose center of gravity coincides with P, the center of gravity of the original triangle A, B, C.

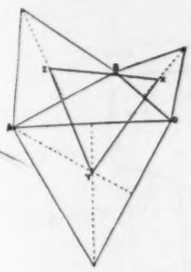


Fig. 1.

Some thirty demonstrations of this theorem have been sent in, but we have space to show only a few typical ones. We have delayed publishing them to afford every one who chose, a chance to send in solutions.

The favorite method of proof is the first here given.

(1) About the triangles $A\,B\,D$ and $B\,C\,E$ (Fig. 2), describe circles intersecting at B and O. Join $O\,B$, $O\,A$, $O\,C$, $O\,D$, $O\,E$, $O\,F$. Because $B\,O\,C\,E$ is a quadrilateral in a circle, and the angle $B\,E\,C = 60°$, therefore $B\,O\,C = 120°$. For similar reasons $B\,O\,A = 120°$. Therefore $A\,O\,C = 120°$. And $A\,E\,C = 60°$. Therefore the circle described about the triangle $A\,E\,C$ will pass through the point O.

The straight line $X\,Z$ joining the centers of the circles $A\,D\,B$ and $B\,E\,C$, cuts their common chord $B\,O$ at right angles; therefore $O\,G\,X = 90°$. For similar reasons $O\,H\,X = 90°$. And because $B\,O\,C = 120°$, and $O\,G\,X$ and $O\,H\,X$ are each 90°, therefore $G\,X\,H = Z\,X\,Y = 60°$.

In the same way it may be shown that angles $X\,Z\,Y$ and $Z\,Y\,X$ each $= 60°$. Therefore the triangle $X\,Y\,Z$ is equilateral.

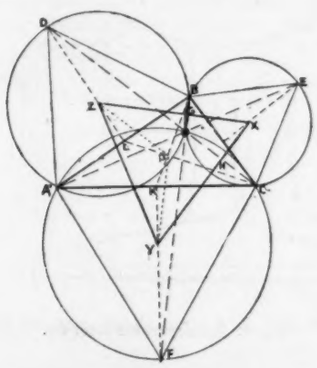


Fig. 2.

(2) The angles $A\,C\,F$ and $A\,O\,F$ are at the circumference of the same segment $A\,O\,C\,F$, therefore $A\,O\,F = A\,C\,F = 60°$. For similar reasons $A\,O\,D$ and $D\,O\,B$ each $= 60°$. Therefore $B\,O\,F$ is a straight line. In the same manner it may be shown that $D\,O\,C$ is a straight line.

In the triangles $A\,B\,F$, $A\,D\,C$, $A\,B = A\,D$, and $A\,C = A\,F$, and angle $D\,A\,C = B\,A\,F$; therefore $D\,C = B\,F$.

Because in triangle $L\,D\,C$, $L\,Z = \frac{1}{2}\,L\,D$ and $L\,P = \frac{1}{2}\,L\,C$, therefore $P\,Z = \frac{1}{2}\,C\,D$, and is parallel to it. For similar reasons $P\,Y = \frac{1}{2}\,B\,F$, and is parallel to it. But $D\,C = B\,F$, therefore $P\,Y = P\,Z$. And $P\,Z$ being parallel to $D\,O$, and $P\,Y$ to $F\,O$, the angle $Z\,P\,Y = D\,O\,F = 120°$. Therefore, P is the center of gravity of the equilateral triangle $X\,Y\,Z$.

Proofs similar to the above have been received from Messrs. J. H. BROWN, FREMONT CRANE, E. L. GRIMES, ALFRED HUME, H. C. LITCHFIELD, "NUT CRACKER," HUGO PAULT, J. H. STUBBS, ATWELL THOMPSON.

A good solution by means of similar triangles is given by Mr. EDW. J. ODLUM, of Welland, Ont. (Fig. 3).

1st. The triangle $X\,Y\,Z$ is equilateral :

Join $Z\,B$, $Z\,A$, $Y\,A$, $Y\,C$, $Y\,F$, $X\,C$, $B\,F$. Then the angle $F\,A\,C$ is two-thirds of a right angle and the angles $Z\,B\,A$, $Z\,A\,B$, $F\,A\,Y$, $A\,F\,Y$, each, one-third. The triangles, $F\,A\,Y$, $B\,A\,Z$, are therefore similar, and $F\,A : A\,Y :: A\,B : A\,Z$, whence alternately $F\,A : A\,B :: Y\,A : A\,Z$: that is, in the triangles $F\,A\,B$, $Y\,A\,Z$, the sides about the angles $F\,A\,B$, $Y\,A\,Z$, are proportional ; and these angles are equal, each of them being equal to the sum of the angle $B\,A\,C$, and two-thirds of a right angle. Hence these triangles are equiangular, and therefore $F\,A$ or $A\,C : F\,B :: A\,Y : Y\,Z$, and in a similar manner from triangles $B\,C\,F$, $X\,C\,Y$, $F\,C$ or $A\,C : F\,B :: C\,Y : Y\,X$; therefore $A\,Y : Y\,Z :: C\,Y : Y\,X$. But $A\,Y$ is equal to $C\,Y$, and therefore $Y\,Z$ is equal to $Y\,X$. Similarly it would be proved that $Y\,Z$, $Y\,X$, are each equal to $Z\,X$.

2d. The center of gravity of $X\,Y\,Z$ coincides with that of $A\,B\,C$. Draw $A\,G$ to middle point of $B\,C$, and $Y\,O\,K$ perpendicular to $Z\,X$. Then O is the center of

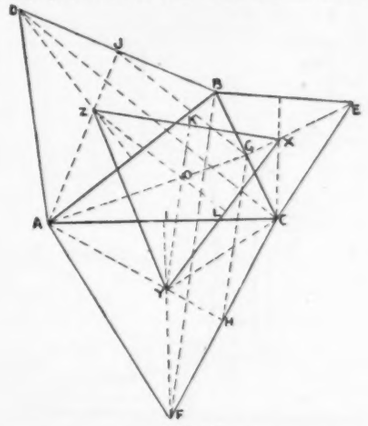


Fig. 3.

gravity of $A\,B\,C$ and $X\,Y\,Z$. Join $G\,H$, then $G\,H$ is parallel to $B\,F$, for $B\,G$ is equal to $G\,C$ and $F\,H$ to $H\,C$.

Now from the proof of the first part the triangles $X\,Y\,C$ and $B\,F\,C$ are equiangular ; therefore the angle $X\,Y\,C$ is equal to $B\,F\,C$. But angle $I\,Y\,C$ is two-thirds of a right angle and $O\,Y\,X$ is one-third. Therefore $I\,Y\,O$ and $X\,Y\,C$ are together equal to one-third of a right angle, and $I\,F\,B$ and $B\,F\,C$ are together equal to one-third of a right angle. Take away the equal angles $X\,Y\,C$, $B\,F\,C$, and the remaining angle $I\,Y\,O$ is equal to the remaining angle $Y\,F\,B$; therefore $Y\,O\,K$ is parallel to $B\,F$. But $B\,F$ has been proved parallel to $G\,H$, therefore $Y\,O\,K$ is parallel to $G\,H$. Therefore $A\,O : O\,G :: A\,Y : Y\,H$. But $A\,Y$ is equal to twice $Y\,H$, since Y is the center of gravity of $A\,F\,C$; therefore $A\,O$ is equal to twice $O\,G$. Therefore the perpendicular $Y\,O\,K$ passes through the center of gravity of the triangle $A\,B\,C$.

Similarly, by joining $J\,G$ and $C\,D$, it is proved that the perpendicular $Z\,L$ passes through O; that is, that the intersection of $Y\,K$ and $Z\,L$ is at O, the center of gravity of $A\,B\,C$.

But the center of gravity of $X\,Y\,Z$ is at the intersection of the perpendiculars $Y\,K$ and $Z\,L$.

Another excellent solution comes from Mr. P. F. SMITH, Instructor in Mathematics at Yale. (Fig. 4.)

Let $D\,E\,F$ be any triangle, and A, B, C the centers of the superscribed equilateral triangles. O is the center of gravity of $D\,E\,F$ (the medial lines are omitted in figure). It will be shown:

1st, that O is the geometrical center of $A\,B\,C$.

2d, that $A\,B\,C$ is equilateral.

1st. Through O and A, let lines parallel to $D\,E$ be drawn. Then we have geometrically, from the positions of A and O,

$$G\,G' = H\,H' = \tfrac{2}{3}\,D\,E.$$

And $G\,G'\,H\,H'$ is a parallelogram. Therefore, $O\,A = G\,H$. In like manner, $O\,C = K\,I$. Now in triangles $G\,D\,H$ and $I\,D\,K$, angle $G\,D\,H = I\,D\,K$ (the angle $H\,D\,K$ being added to equals,) $D\,K = D\,G = \frac{1}{2}\,D\,E$; and $D\,H = D\,I = \frac{1}{2}\,D\,F$. Therefore, the triangles are equal, and $G\,H = K\,I$; or $O\,A = O\,C$. Similarly $O\,A = O\,C = O\,B$, and O is then the geometrical center of $A\,B\,C$. Q. E. D.

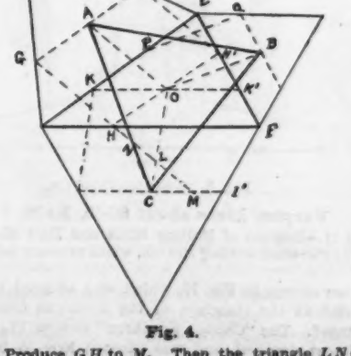


Fig. 4.

2d. Produce $G\,H$ to M. Then the triangle $L\,N\,C$ is isosceles, since $O\,A\,C = O\,C\,A$. ($O\,A$ equalling $O\,C$) and as $O\,A\,C = L\,N\,C$ (corresponding angles) therefore $L\,N\,C = O\,C\,A$. Also, angle $D\,I\,K = D\,H\,G = L\,M\,C$, (from equal triangles and corresponding angles) and $K\,I\,C = 120° - D\,I\,K = L\,C\,M$. Therefore, $C\,L\,M = 180° - (L\,C\,M + L\,M\,C) = 180 - (120°) = 60°$. But $C\,L\,M = L\,N\,C + L\,C\,N = 2\,L\,N\,C$. Therefore $L\,N\,C = O\,C\,A = O\,A\,C = 30°$. In like manner, it may be shown that $O\,A\,B = O\,B\,A = 30°$, viz.: by treating of $G'\,H'$ produced and $P\,P'$. Hence the angles of $A\,B\,C$ are all equal, and the triangle is therefore equilateral. Q. E. D.

The following, by Mr. FRED. MORLEY, of Quincy, Ill., is very concise. (Fig. 5.)

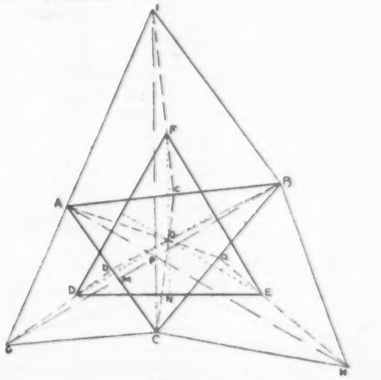


Fig. 5.

Draw $F\,O$, $D\,O$ and $E\,O$ and produce to intersect sides $D\,E$, $F\,E$, and $D\,F$. Draw $I\,C$, $G\,B$, and $A\,H$. Since $Fc = \frac{1}{2}\,Ic$ and $cO = \frac{1}{2}\,cC$, $F\,O = \frac{1}{2}\,I\,C$ and is parallel to it. For same reason $D\,O = \frac{1}{2}\,G\,B$ and is parallel to it, and $O\,E = \frac{1}{2}\,A\,H$ and is parallel to it.

Now $I\,C = G\,B = A\,H$. For triangle $I\,A\,C = B\,A\,G$ and triangle $G\,C\,B = A\,C\,H$ (two sides and included angle equal). Hence $F\,O = D\,O = O\,E$, and O lies at center of circle passing through F, D, and E. Since triangle $I\,A\,C =$ triangle $B\,A\,G$, angle $I\,C\,A =$ angle $A\,G\,B$. Then in triangles $A\,M\,G$ and $M\,P\,C$ the angles at M being opposite are equal, and as $I\,C\,A = A\,G\,B$ as just shown, angle $G\,A\,M = 60°$, must = angle $M\,P\,C = G\,P\,C = D\,O\,N$, similarly $N\,O\,E = 60°$, etc.

Hence triangle $F\,E\,D$ is equilateral and has O for it center of gravity.

We have space for but one more short proof, which was sent by Mr. A. R. BULLIS, of Macedon, (Fig. 6.)

1. Revolve the triangle $A\,B'\,C$ about A into the position $A\,B''\,C''$. Then since $A\,B'$ and $A\,C'$ are like parts of $A\,C$ and $A\,B$, $B''\,C'$ is parallel to $C\,D$. Similarly $A''\,C'''$ is parallel to $C\,D$. Hence, the angle at C' is 60°, since, in the parallel position of the sides, each makes an angle of 30° with its original position.

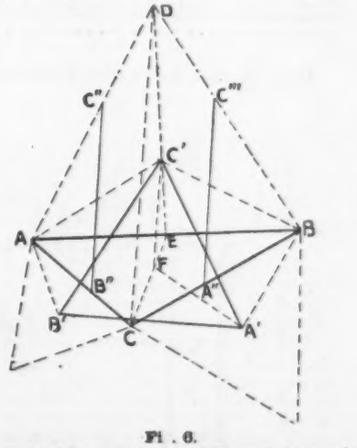


Fig. 6.

2d. Take $E\,F = \frac{1}{2}\,E\,C$, then $C'\,F$ bisects the angle C' because it is parallel to $B''\,C'$; therefore F is the centre of gravity of both triangles.

Other geometrical proofs, equally, or a little less, excellent, have been received from Messrs. N. M. GRAY, G. C. HADDOCK, H. M. MARSHALL, JOSEPH P NOYES, WM. N. PAGE, P. H. PHILBRICK, A. D. ROBINSON, W. C. SHOEMAKER, O. SONNE, F. A. WEIHE, CHAS. C. WENTWORTH, V. M. WITMER, and B. C. WOOLEY.

A few only of the proofs sent have been found incorrect or unsatisfactory. In fact, we have read so many good demonstrations of the proposition that we must now tell our readers that we do not want any more.

Varying Ideas about 80-lb. Rail Sections.

It became the duty of Mr. J. D. HAWKS, Chief Engineer of the Michigan Central Railway, to adopt last year a standard section for an 80-lb. rail. Desiring to get all possible light upon the subject and to act advisedly, Mr. HAWKS sent requests to all the prominent rolling mills and to various roads having such sections already in use to submit the designs which they approved. The result was the series of somewhat diverging designs which we present in this issue, drawn to a uniform scale of one-half full size. Deeming them of general interest, as we do also, Mr. HAWKS has kindly placed the whole series at our service, and through us at the service of our readers. The result of his own study of them is the section shown in Fig. 17, which was adopted Nov. 24, 1888, as the standard of the Michigan Central Railroad. The "Canada Southern" section, Fig. 12, is almost identical, and was adopted Nov. 15, 1888; but the Canada Southern being a part of the Michigan Central, it is not likely that two sections differing so slightly will be both used, and Fig. 17, therefore, may be taken as representing the final standard of both roads.

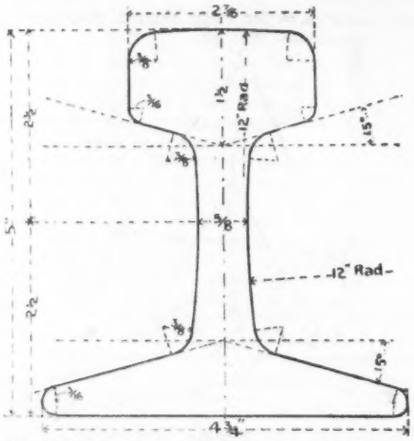


Fig. 1. North Chicago R. M. Co. (Des. by E.C. POTTER.)

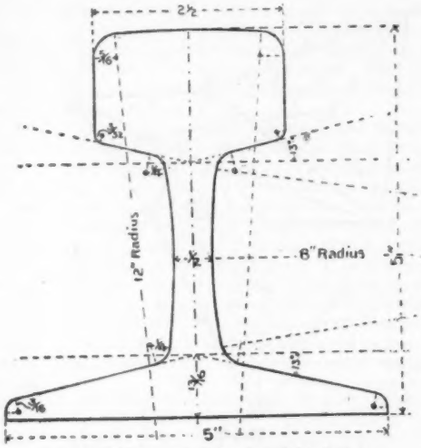


Fig. 2. North Chicago R. M. Co.

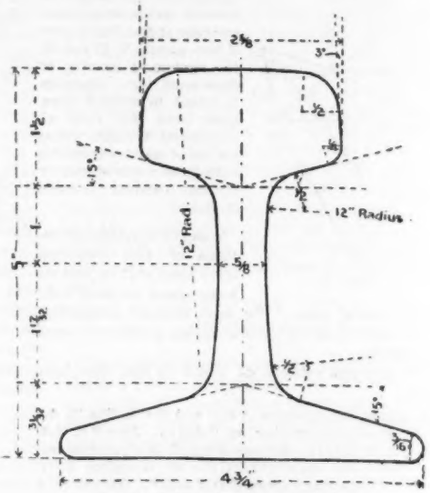


Fig. 3. North Chicago R. M. Co.

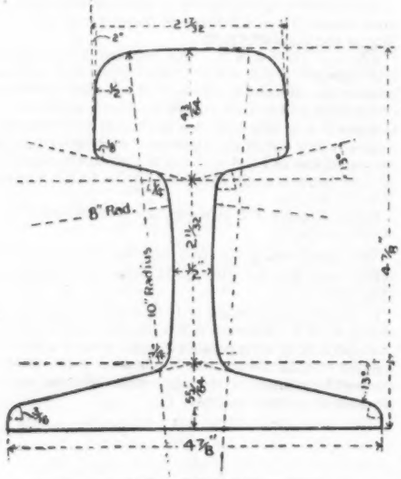


Fig. 4. Cambria Iron & Steel Works.

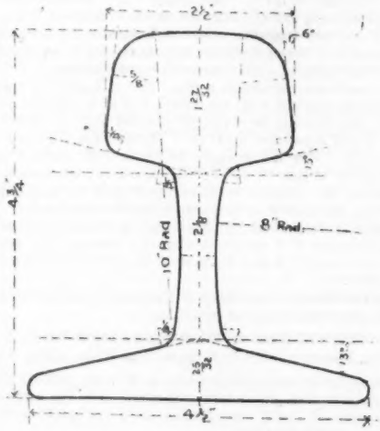


Fig. 5. Cambria Iron Co. (75 lbs. Old Penna. R. R. sec.)

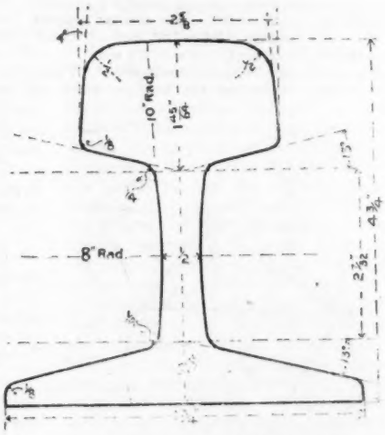


Fig. 6. Pennsylvania Steel Co.

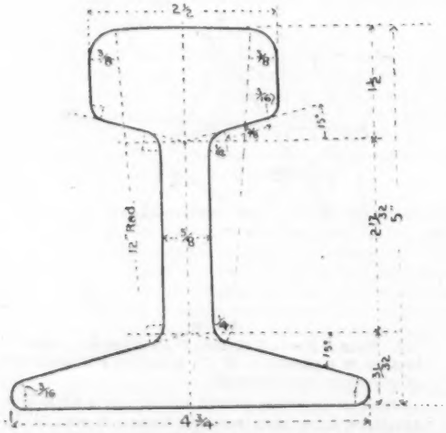


Fig 7. Union Steel Co. (Designed by R. FORSYTH.)

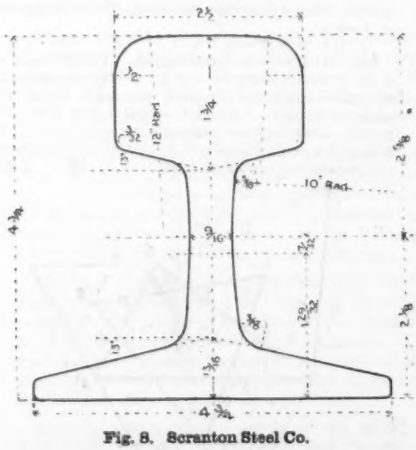


Fig. 8. Scranton Steel Co.

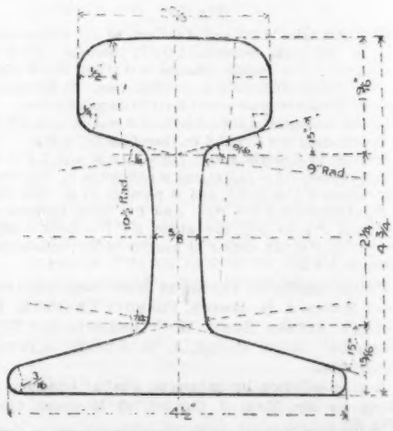


Fig. 9. Union Steel Co. (Designed by R. FORSYTH.)

Varying Ideas about 80-lb. Rails.

Figs. 1-11.—Designs of Rolling Mills and Rail Makers.

(See also Fig. 19, Design of Cleveland Rolling Mill Co., which properly belongs to this group.)

The sections originally submitted are nearly all reproduced by engravings, but some differed so little from those shown that they were not engraved. The complete list of sections is:

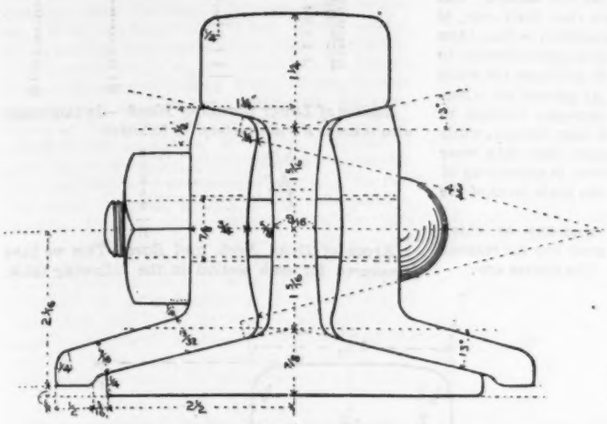


Fig. 12. Canada Southern Railway, 44-in. Splice.
(Weight of splices per pair, 180 lbs.) Head should be read 1⅛ ins. high instead of 1¼ ins.

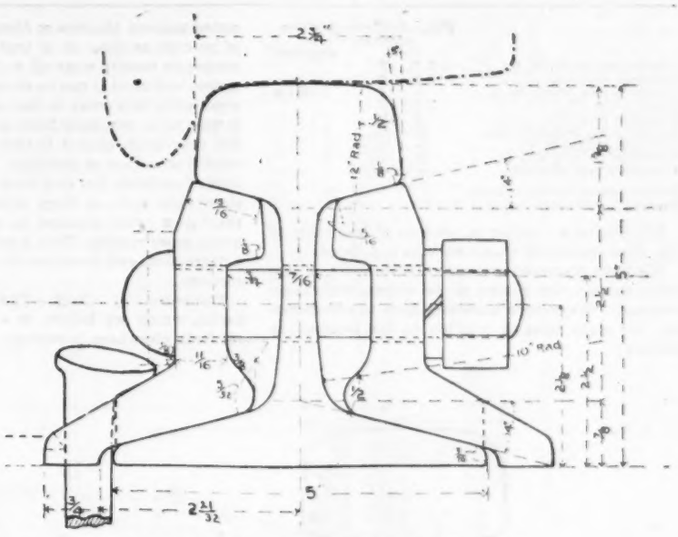


Fig. 13. Lehigh Valley Railway. (In substance.)
Design of W. F. MATTES, Lackawanna Iron & Coal Co.

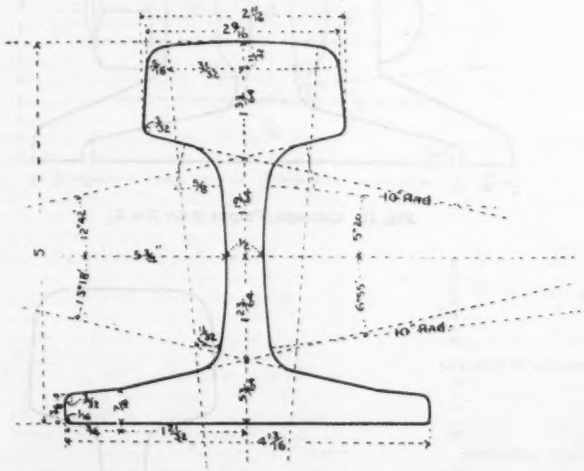


Fig. 14. New York Central & Hudson River Railroad. (12½ in. top radius.)

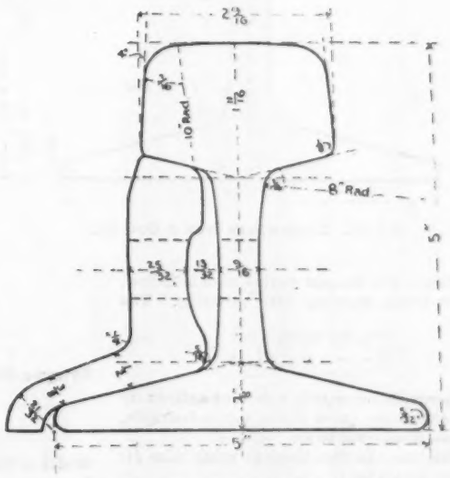


Fig. 15. Pennsylvania Railroad. (85 lbs.

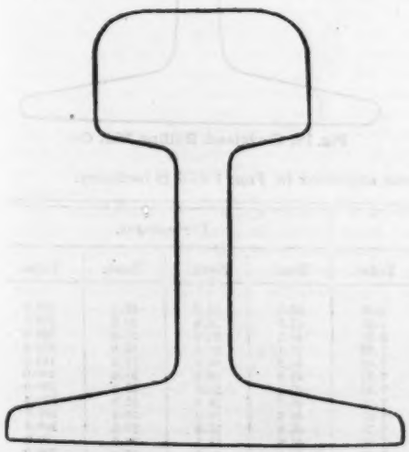


Fig. 16. Goliath Rail, Belgian State Railways. (104 lbs.

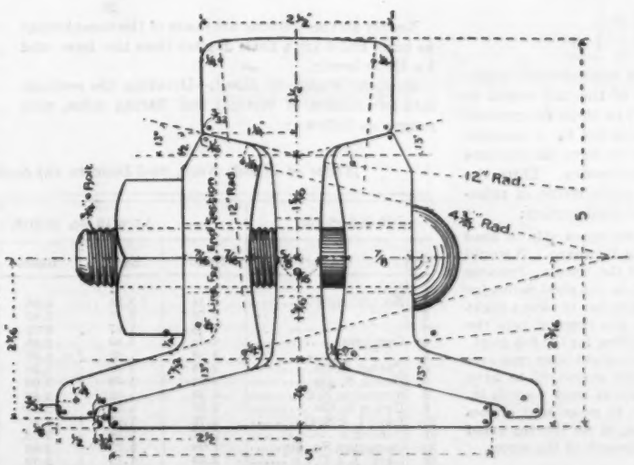


Fig. 17. Michigan Central Railway.
Standard adopted by J. D. HAWKS, Chief Engineer (44-in. Bevelled Splice.)

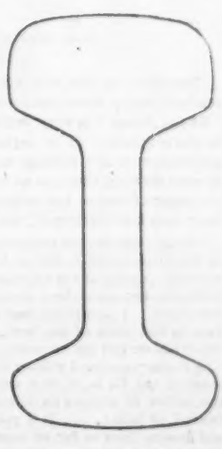


Fig. 18. London & South-western Railway.

Varying Ideas about 80-lb. Rails.

Designs of Railway Officials.

[This entire series of Rail Sections Figs. 1 to 18, and Figs. 18-19, are reduced to a uniform scale of one-half full size from designs submitted to Mr. J. D. HAWKS, Chief Engineer, Michigan Central Railway. Fig. 17 shows the design finally adopted by Mr. HAWKS.]

	Figs.	Sections engraved	Sections not engraved
North Chicago R. M. Co.....	1, 2, 3	3	
Cambria Iron Co	4, 5	2	
Pennsylvania Steel Co.....	6	1	1 (85 lbs.)
Union Steel Co	7, 9	2	
Scranton Steel Co.....	8	1	
Lackawanna Iron & C. Co....	10	1	1
Carnegie Phipps & Co	11	1	1
Cleveland Rolling Mill Co....	19	1	—
Unknown (not marked).....	—	—	1
Total designs by rail-makers			16
Designs by railway officials	12 to 18		7

In addition a number of sections of less than 80 lbs. were submitted which we have not listed.

We have discussed somewhat, editorially, in another column, the lessons to be drawn from these sections. We confine ourselves here to summarizing the main facts in relation to the sections, as follows:

consciousness theories so discordant with the facts of practice as this. It is true that outside rails on curves do rapidly wear off to "fit the flange," but unless and until it can be shown that their rate of wear after they come to that condition is less than it was while new, such facts surely point directly to the conclusion that it is best to postpone the worn condition as long as possible. At present not a particle of evidence has ever been brought forward to show that rails so worn wear less rapidly, while there is a great amount to show that they wear much more rapidly. This, however, is something of a digression, and we return to the main facts of the sections.

Thickness of Neck.—The tendency to thick necks, which we believe is a good one for reasons set forth elsewhere, is evident. The figures are:

	Vertical Sides	Flaring	Total
2 7/16 in.	1	—	1
2 5/16 "	5	2	7
2 3/16 "	—	1	1
2 1/16 "	1	1	2
2 "	—	1	1
1 15/16 "	—	2	2
1 13/16 "	—	4	4
1 11/16 "	—	2	2
	7	13	20

Radius of Lower Corner of Head.—In this detail also there is a wide variety as follows:

1/2 in.	3
7/16 "	5
3/8 "	3
5/16 "	4
1/4 "	2
	17

Areas of Head, Neck, and Base.—This we have measured for each section in the following table.

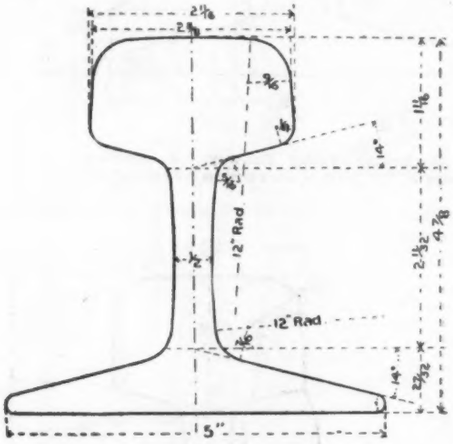


Fig. 10. Lackawanna Iron & Coal Co.

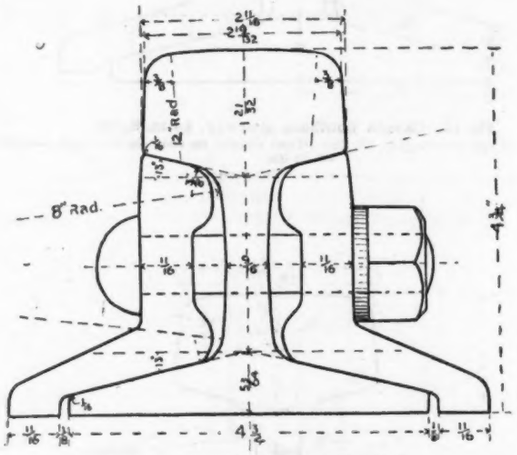


Fig. 11. Carnegie, Phipps & Co. No. 2.

Top Radius.—The longest radius used is 12 ins., the shortest 10 ins., showing little variation. The totals are:

12 in.	top radius	14
10 1/2 "	" "	1
10 "	" "	4 19

There appears, therefore, to be a decided uniformity of opinion that some curve in the top is desirable. Nevertheless, it may not be so.

Corner Radius.—In this there is much more diversity. The totals are:

Less than 1/4 in.	1/8 in.	2	
	1/16 "	8	
	3/16 "	3	11
1/4 in. or over	1/4 in.	7	
	5/16 "	1	
	3/8 "	1	9

The effect of the now almost exploded and undefended theory that the corner of the rail ought to "fit the flange" is very evident in these figures and in the sections. It is perhaps aided by a natural preference of the rolling mills to have the sections in easy flowing lines, so as to roll easier. Thus, the manager of one of the rolling mills wrote in reference to a first outline of the adopted section:

I would criticize the corner of the upper side of head of the proposed 80-lb. rail as being too sharp. It would wear off quickly at the expense of the wheels. Practice indicates that somewhere about 5/16-in. is a good radius for this curve. I also think that it is better to have a slight flare to the sides of the head, as you thereby help the wheel a little and get increased bearing for the fish joint.

In this connection I will say that it might be an improvement on the 4 5/16 in. section sent [not engraved] to have the radius of corners on lower side of head made 1/8 in. instead of 1/4 in. . . . . It is policy to make easy curves and flowing lines as far as possible, as we thereby avoid strains which interfere with the strength of the metal.

Considering that it is only necessary for a man to walk out to the nearest track he can find to see that rails originally sharp-cornered do not "wear off quickly at the expense of the wheels," but on the contrary get a sharper rather than a rounder corner, except on the outside of curves, it is astonishing that practical men should evolve from their inner

7/8 in. neck	2
13/16 " "	5
3/4 " "	1
11/16 " "	8
5/8 " "	4
	20

Extreme Height.—This ranges as follows:

5 in.	10
4 15/16 "	2
4 3/4 "	8
	20

Width of Base.—This ranges as follows:

5 in.	7
4 15/16 in.	1
4 7/8 "	9
4 13/16 "	1
4 3/4 "	2
	20

Nearly all the sections are made of the same height as base, but 6 are a little higher than the base, and 1 a little lower.

Extreme Width of Head.—Dividing the sections into two classes, of vertical and flaring sides, this ranges as follows:

Fig. 19. Cleveland Rolling Mill Co.

Areas of Head, Neck, and Base in the Sections engraved in Figs. 1 and 19 inclusive.

Rail Section. No.	Maker.	Area in sq. inches. Head.	Neck.	Base.	Total.	Percentages. Head.	Neck.	Base.	Total.
1	No. Chicago	3.14	1.84	3.05	8.03	39.1	22.9	38.0	100.0
2	"	3.73	1.47	2.60	7.80	47.9	18.8	33.3	100.0
3	"	3.28	1.87	3.02	8.17	40.1	21.9	37.0	100.0
4	Cambria..... ...	3.64	1.40	2.68	7.72	47.1	18.1	34.8	100.0
5	"	3.86	1.23	2.36	7.45	51.9	16.5	31.6	100.0
6	Penna. S. Co.....	3.84	1.30	2.58	7.72	49.8	16.8	33.4	100.0
7	Union S. Co.....	3.17	1.69	3.00	7.85	40.3	21.5	38.2	100.0
8	Scranton S. Co.....	3.80	1.42	2.48	7.70	49.3	18.4	32.3	100.0
9	Union S. Co.....	3.30	1.53	2.74	7.57	43.6	20.2	36.2	100.0
10	Lake L. & S. Co.	3.76	1.37	2.57	7.70	48.8	17.8	33.4	100.0
11	Carnegie	3.86	1.46	2.58	7.90	48.9	18.5	32.6	100.0
12	Canadian So. Ry.....	3.29	1.73	2.86	7.87	41.8	21.9	36.3	100.0
13	Lack. I. & C. Co	3.69	1.45	2.70	7.84	47.0	18.5	34.5	100.0
14	N. Y. C. & H. R.....	3.44	1.60	2.73	7.77	44.2	20.6	35.2	100.0
15	Penn. R. R.....	3.83	1.49	2.99	8.31	46.1	17.9	36.0	100.0
16	"Goliath"	4.88	2.10	3.49	10.47	46 6	20.0	33.4	100.0
17	*Mich. C*	3.29	1.72	2.86	7.87	41.8	21.8	36.4	100.0
18	London & S. W.....	3.89	1.87	2.50	8.26	47.1	22.6	30.3	100.0
19	Cl'd R. M. Co.....	4.08	1.34	2.43	7.85	52.0	17.1	30.9	100.0

We have analyzed these figures somewhat in another column.

The areas were measured by the planimeter from our own tracings of the full-scale sections. (Engravings were all reduced photographically one-half from these tracings.) The areas, consequently, are not as accurate as if they had been measured on the original drawings, and the planimeter, moreover, does not work quite as accurately on tracing cloth as on drawing paper. These sources of error may in part explain the considerable variation shown in the table from the 8.00 sq. ins. area required to give an exactly 80-lb. rail, but only in part. In the main the discrepancies are in the sections themselves; but setting the rolls $\frac{1}{8}$ in. further apart will add 0.31 sq. ins. to the section, bringing most of them which now fall under 8 sq. ins. up to that section, and, we may add, giving a better section in most cases. To eliminate the effect of these variations in total area, we give in the last four columns the percentage of the total area in head, neck, and base, the head in all cases being taken to include all above the lower sides of the head prolonged to an intersection, and the base, all below the top sides of the base similarly prolonged.

Willans' Central-Valve Triple-Expansion Sewage Pumping Engine.

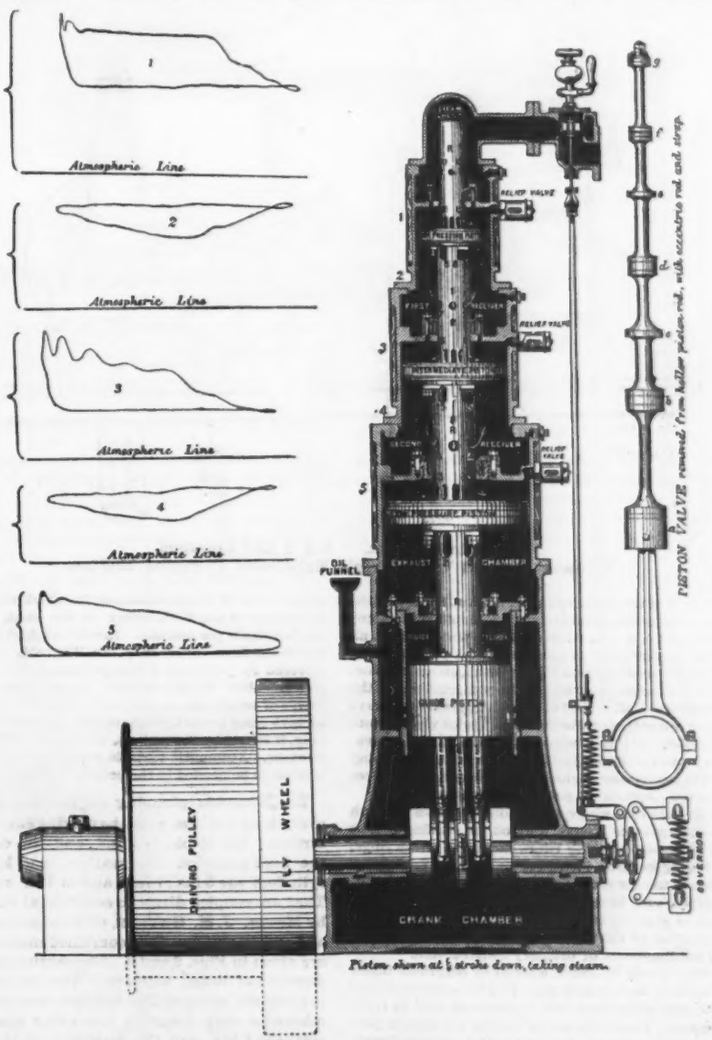
The sewage disposal works at Kingston-on-Thames, England, contain many novel features, but perhaps none more so than the peculiar type of pumping engine which we illustrate, for the drawings of which, and the substance of the following description, we are indebted to *The Engineer*. The main feature of the device is to substitute high speed, high pressure, and small space for the usual huge mechanisms for such work; and it will hardly be questioned that the result is attained in a highly ingenious manner.

The whole of the engines on the Willans' central valve system illustrated, together with the boilers and other fittings, have been made by Messrs. Willans & Robinson. They include two engines, each of 40 H. P., for driving the mixing mills, drying cylinders, air compressors, and other machinery at the works; three pumping engines, each capable of raising 100,000 galls. of sewage per hour; and three—for Surbiton—each able to raise 45,000 galls. per hour—eight engines in all. The maximum lift of the pumps is 19 ft. when clearing the pump wells; normally it is about 10 ft. for the Kingston and 13 ft. or 14 ft. for the Surbiton pumps. All the engines are non-condensing, and work with steam of 160 lbs. pressure. The two driving engines and the three larger pumping engines are on the triple-expansion principle; the three smaller pumping engines—for Surbiton—are compound.

For the horizontal pumping engines originally contemplated for Kingston alone, an engine-room 50 ft. × 40 ft. was required. That now occupied measures 25 ft. × 14½ ft.—about one-sixth as large. Two driving engines are speeded to run at 450 revs. per minute; the Kingston pumping engines at 350 revs., and the Surbiton pumping engines at 550 revs. The engines are single-acting like the well-known Westinghouse engine; steam acts upon the pistons only during the down-stroke. The up-stroke is made by the momentum of the fly-wheel, against an air cushion in the lowest cylinder. (See section of engine, Fig. 1.)

The crank-shaft revolves in a chamber filled to a certain height with lubricant—mixed water and oil—and splashes it, in the form of a constant fine spray, over the connecting rods and other moving parts; the lubrication is thus automatic, and the main bearings are in fact continuously flooded with oil. As the lubricant escapes from the crank-chamber but slowly, and only at points where it can be easily caught and returned, the consumption of oil is very small, 1 to 2 pints per week. The automatic lubrication of the engine is of course an important element in its success, and in this it is exactly like the Westinghouse.

Fig. 1 gives a section through one of the 40 I. H. P. driving engines, to ½ of actual size, the total height of the engine to top of steam-chest being about 6 ft. 8 ins. The engine is arranged with the high-pressure cylinder above the intermediate cylinder, and with the latter above the low-pressure. The rod *R* is of large diameter, and is hollow, and the valve for admitting and exhausting the steam from the several cylinders works up and down inside it, in the center of the engine—hence the name "central valve." A separate view of the valve is given at the side of Fig. 2. It is driven in the usual way by an eccentric, but since the valve face —*i. e.*, the inner surface of the hollow rod—moves up and down with the pistons, the source of the valve motion, *i. e.*, the eccentric, must move up and down with the pistons also. This is effected by mounting the eccentric on the crank pin, instead of on the shaft as usual. The ports through which the steam enters and leaves the respective cylinders are simply holes in the hollow rod, shown at *e e*, 6, 6, and 3, 3. These are exposed alternately to steam coming from above, through the rod, and to exhaust—also through the rod—downwards, according as the corresponding pistons of the valve, marked



Willans' Central-Valve Triple Expansion Pumping Engine.
Fig. 1. Section and Indicator Diagams.

f, *d*, and *b*, pass below the holes or above them. *The Engineer* thus describes the operation of the engine:

Steam enters at the top, through the governor throttle-valve shown in section, into the steam-chest. The top of the hollow rod, though uncovered, is closed against the steam by the uppermost piston *g* of the valve, which works in the part above the holes 10, 10. Steam can therefore enter the rod only when the holes 10, 10 are in the steam-chest, as they are when the high-pressure piston is near the upper part of its travel. On commencing the down-stroke, *f* is just passing below the holes *e e*, and therefore admits steam into the first or high-pressure cylinder by way of 10, 10, and 9, 9; *f* rises again, and closes the ports 9, 9, when the piston has descended about three-quarters of its stroke; but cut-off is effected earlier than this by the holes 10, 10, leaving the steam-chest and passing through the gland in the cylinder cover, thus losing their supply of steam. It is evident that cut-off may be made to take place at any part of the stroke, merely by making the holes 10, 10, higher or lower in the rod; the lower they are, the earlier in the stroke will they leave the steam chest. The same effect is produced by altering the height of the gland in the cylinder cover. After cut-off the steam acts expansively on the high-pressure piston in the usual way. By the time the piston has reached the bottom of its stroke, the piston valve *f* has passed above the ports *e e*, and, as the valve *e* in the piston valve permanently blocks the passage between 8, 8, and 7, 7, a way is opened from above the high-pressure piston, through *e e* and out again by 8, 8, into the space below the piston, and marked "First Receiver." During the up-stroke, effected by the momentum of the fly-wheel only, the steam is merely transferred, practically without change of volume or pressure, into the receiver. The "receiver" might be open to the atmosphere, so as to allow the steam to escape at once, the two lower cylinders with their pistons and valves being omitted. In that case, the cycle would be already complete, and in fact the above description would be all the description needed for a Willans "simple" engine, such as would be used where only low-pressure steam was available. In the present case, however, the receiver—which is partly composed of the lower end of the high-pressure cylinder—forms also the steam-chest for another cylinder, which in a compound engine would be the last of a series of two, but which here is the second of three.

At the beginning of the succeeding down-stroke, steam passes from the receiver, by the holes 7, 7, into the hollow rod again, and out by 6, 6, into the intermediate cylinder, until cut-off occurs by the descent of the holes, 7, 7, through the cylinder cover. On the next up-stroke the steam exhausts, just as described above, through 6, 6, and 5, 5, into the second receiver; in the next down-stroke it passes into the low-pressure cylinder, through 4, 4, and 3, 3; in the next up-stroke it is transferred, through 3, 3, and 2, 2, into the "exhaust chamber," which is in communication with the atmosphere, but it is not until the third revolution after that in which the steam enters the high-pressure cylinder that it is finally expelled from the engine. It will be noticed that the full pressure in the steam-chest is constantly acting upon the valve piston *g*. This ensures that the eccentric rod shall be kept con-

stantly pressed against the eccentric, as well on the up as on the down stroke. With the steam pistons, the case is different. They are much heavier, and they are all in equilibrium during the up-stroke, for there is at that time communication existing between the upper and lower sides of all of them. Special means, therefore, are required for checking their momentum on the up-stroke, so as to keep the connecting-rod brasses truly in constant thrust. This object is carried out—without, however, adding any special parts to the engine—by an arrangement which is the subject of a separate patent. The guide, which takes the side thrust of the connecting-rod, and is more usually described in ordinary engines as the crosshead—is in the form of a piston, moving in a cylinder closed at the top; this is shown in Fig. 1. At the bottom of its stroke it uncovers certain holes, *l*, *l*, which place the guide cylinder momentarily in communication with the atmosphere. As there is no other outlet from it, the upward movement of the guide piston compresses the air contained in the guide cylinder, until at the top of the stroke a considerable pressure is reached sufficient to stop the line of pistons, etc., without shock, and without allowing the upper brass to leave the crank-pin. In fact, an air cushion is substituted for the usual steam cushion, and since the pressure at which the compression of the air commences—unlike that of exhaust steam—is always the same irrespective of whether the engine exhausts into the atmosphere or into a vacuum, the cushioning is invariable in its action, and is just as effective in a condensing as in a non-condensing engine. The compressed air gives out its power again on the succeeding down-stroke.

It will be seen that where the piston-rod passes through the various cylinder covers, a gland or stuffing-box is formed by cast-iron spring rings, similar to piston rings, but springing inwards instead of outwards. Such rings have been in use for many years in various types of Willans engines, and have been found to keep extremely tight and to give no trouble. They apparently offer a perfect solution of the difficulties which attend the use of internal stuffing-boxes of ordinary construction.

With Fig. 1 will be found a series of diagrams taken during trials to be referred to. It will be noticed that diagrams are taken from the receivers as well as from the cylinders. The reason is that during the earlier part of the down-stroke the pressure in both receivers diminishes, returning approximately to the original pressure at the end. The mean reduction of pressure in the receiver throughout the down-stroke is, of course, a reduction in the back pressure against which the piston is working, and is a virtual addition to the power developed in the cylinder above. For this reason the diagrams from the receivers have to be counted in the power. It will be seen that each receiver interposes a most effectual thermal separation between the cylinders; the steam expanding in one cylinder, and expelled thence, does not continue its expansion in the next cylinder of the series until after the lapse of half a revolution. This prevents the temperature in each cylinder from falling below that proper to the pressure shown by the straight line at the bottom of each cylinder diagram. It is claimed that this is an important feature peculiar to the Willans engine. Ensuring that the pressures, and therefore the temperatures, recorded in the diagrams from successive cylinders shall never overlap, has, Mr. WILLANS holds, a great influence upon the thermo-dynamic efficiency of the engine. Mr. WILLANS maintains that one of the chief causes of inefficiency in steam engines is the existence of a large range of temperature in any one cylinder, i. e., a large difference between the temperatures of the incoming and the outgoing steam. To lessen this range is the object aimed at in the multiplication of cylinders incidental to the compound or triple-expansion systems, in which the entire expansion—and fall of temperature—of the steam is carried out in two or three stages instead of in one. In the Willans engine the object is attained more perfectly, it is claimed, than in any other, and the results are correspondingly better; in fact, they approximate to the result, as regards smallness of range of temperature, which would be obtained by using four, or even five stages of expansion in an ordinary engine, without the accompanying complication and losses from friction and wire-drawing. It may be noticed that two well-known "refinements," sometimes supposed to be indispensable in high-class engine work, are absent from the Kingston engine, viz., steam jackets and automatic variable expansion gear. As regards the first, it is pointed out that steam jackets are only useful upon cylinders in which there is an unduly large range of temperature, or in which the changes of temperature are slow, owing to the small number of strokes made per minute. In such engines a part of the loss from these causes may, Mr. WILLANS thinks, be recovered by judicious steam-jacketting, but even this is questionable. In the Willans engines there is no large range of temperature, and such changes of temperature as take place are extremely rapid; consequently, jacketting, it is held by the makers, would be of little or no advantage. Automatic variable expansion gear is not considered to be needed in the present instance.

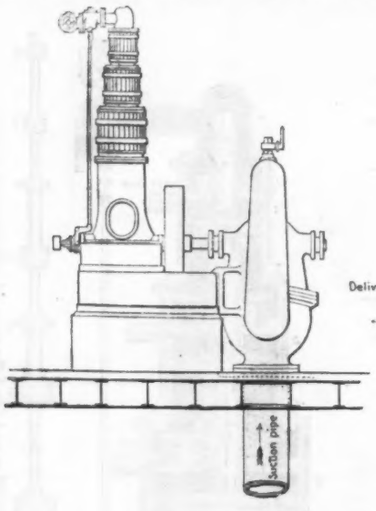


Fig. 2. Side Elevation.

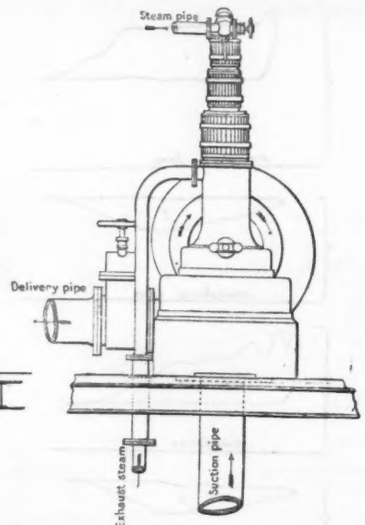


Fig. 3. End Elevation.

Willans' Central Valve Triple Expansion Pumping Engine.

The Kingston pumping engines are identical in everything but size with the driving engines just described. The stroke is 5 ins., and the diameters of the high pressure, intermediate, and low-pressure cylinders are 5 ins., 7 ins., and 10 ins. respectively. They are coupled direct to centrifugal pumps, made by Messrs. J. H. GWYNNE, of Hammersmith. Side and end elevations of the combined engine and pump are given in Figs. 2 and 3. The suction and delivery pipes are of 10 ins. diameter. The Surbiton pumping engines are smaller, and are compound only; otherwise they resemble the other engines. The stroke is 4 ins., and the diameters of the high and low-pressure cylinders are respectively 5 ins. and 7 ins. The suction and delivery pipes are of 7 ins. diameter. There are no foot valves to the suction pipes, but sluice valves are fitted on the delivery pipes, close to the engines, and automatic weighted flaps at the ends of the delivery pipes. The pump cases are filled when starting by a steam exhauster, which creates a vacuum in a stand-pipe communicating with the various pump casings. The quantity of sewage which could be delivered on an emergency by the Kingston engines—not taking the Surbiton engines into account—would probably approach 10,000 galls. per day of 24 hours, a fact which may fairly be considered remarkable when the small size of the machinery is considered.

Very economical results are claimed for these engines. The following* are particulars of one out of a large number of trials of an engine in all respects identical with the driving engines for the Kingston sewage works (steam supplied during the trials from one of the Kingston boilers):

Boiler pressure above atmosphere			160 lbs.
Ratio of total expansion corrected clearance			6.158
Duration of trial			5 hrs. (exactly)
Number of revolutions per minute, mean			401.2
Length of stroke			6 ins.
		sq. ins.	lbs.
High-press. piston	net area,	34.5; mean press.	39.91
" " underside	" "	31.416; " "	15.06
Intermediate piston	" "	71.472; " "	22.04
" underside	" "	65.973; " "	6.8
Low-pressure piston	" "	141.340; " "	15.045
Total mean press. referred to area of low press.			42.424
Indicated horse-power, mean			36.44
Total feed-water used, per hour			666.4
Feed-water used per indicated horse-power hour			19.11

*These particulars are extracted from Table III, page 44, annexed to a paper on "Economy Trials of a Non-Condensing Steam Engine—Simple, Compound, and Triple," read before the Institute of Civil Engineers, on March 13, 1888, by P. W. WILLANS, M. Inst. C. E. ("Proceedings," vol. xciii.; sessions 1887-8; part iii.)

Electric Welding.

On Monday evening, March 4, an exhibition and reception to members of the press was given by the Thomson Electric Welding Co. at the station of the Malden Electric Co., Malden, Mass., at which time a number of machines of varying sizes and types were shown in operation. About fifty representatives of the press from all parts of the country were present. One machine was adapted to the welding of various kinds of metal, such as brass, copper, German silver, etc. Another was designed especially for wrought-iron pipe, and a number of other special machines were also operated.

The exhibition began by the welding of a ¼-in. iron bar, and on the same machine were successively welded pieces of 5-16-in. cooper, ⅜-in. brass, ½-in. cooper, ¾-in. brass, and 1-in. iron. Another machine welded specimens of 2-in. extra heavy wrought-iron pipe, and the largest machine welded 2-in. solid iron.

Besides the above, specimens were shown of various forms of welding, such as rings, chains, zinc plates, cast-iron pieces, pieces of aluminium, etc.

After the exhibition refreshments were served in the station to those present, and all seemed greatly pleased with the performance of the machines.

Another exhibition was given at the same place Thursday night, March 7, at which Governor AMES was present and other prominent men. A full account of these experiments will be given in an early issue.

The St. George Bridge Disaster.

We have just had another example of the consequences of imperfect bridge floors in the great disaster which we illustrate, and which we briefly described last week. Our first view is a general one of the entire bridge immediately after the accident; and the second, a view to a larger scale of the further end of the bridge, showing more clearly the condition of the bridge floor and trusses after the event.

St. George is a small village of about 600 people, on the Grand Trunk Railway, 21 miles west of Hamilton, Ont. The accident happened on the evening of Feb. 27, to the so-called St. Louis express. About 1,220 ft. beyond the bridge there was a switch, and 352 ft. from the bridge another switch, both on a ⅛° curve. Possibly something was wrong at these switches, but probably not. In any case, about 450 ft. from the end of the bridge the engineer noticed that a driver tire was broken; it was so badly broken that it left the wheel, and rolled off into the field, about 150 ft. from the end of the bridge, in sight of a passenger on the train. Then the coupling rod broke, very naturally, and it had been tearing up the roadbed for some distance before reaching the bridge, so that on entering the bridge the whole train was derailed; but it is evident from what followed that it was not then very badly derailed.

The bridge itself, so far as we can ascertain, consisted of 8 spans of 50 ft. each. The broken span is the fifth. The first two spans are not shown in our engraving. The structure itself we judge to have been in all respects a solid and substantial one, but the floor consisted only of what the Superintendent calls "needle beams," on which the rails directly rested. We judge the sticks to have been about 8 x 12, and placed at least 8 ins. apart in the clear, if not more. There was a heavy guard-rail along the outer ends of these "needle-beams," but there were no guard-rails proper, close to the rails, and no re-railing guards at the end of the bridge. The roadmaster testified that the management did not believe in or use any such precautions, "even at Niagara."

To the ease with which this floor was disturbed and destroyed, rather than to the broken tire or coupling rod, appears to be due the disastrous consequences which, according to the latest reports, have caused 13 deaths and 29 injuries, many of them serious, and a money loss of over $200,000. In the first place, it is highly probable that had the bridge been protected by re-railing guards, the derailed cars, at least, if not the engine, would have been restored to the rails as they passed on the bridge, and the final catastrophe postponed for 150 ft. further, when the bridge would have been passed. Had the brakes been put on promptly, likewise (which does not appear to have been the case), the final smash-up might have been averted altogether.

of the next span behind, where it will be seen caught in the iron-work.

The train consisted in order of the following vehicles, to which we append the fate of each.

1. ENGINE. 2. TENDER. 3. BAGGAGE. 4. SMOKING CAR. Escaped, but were derailed, and disturbed the floor pushing the ties ahead and gathering them together, causing wreck of the following coaches from track being unsupported.

5. FIRST-CLASS COACH.

First car to fall. Probably pushed off sidewise by the pressure from behind Struck wheels down and at once collapsed. Every person in it killed or injured.

6. PARLOR CAR *Toronto*.

Central truss apparently gave way under this, causing

To slacken speed to 12 miles per hour (as wa recommended) on so small a structure forever after, because of one accident, is a quite senseless precaution; but we could not, if on a jury, exonerate from blame for what has happened the management of that or any other corporation which had spaced ties so far apart and neglected to provide any effective guard rail system. The probabilities are exceedingly strong that had the "needle-beams" been spaced 2 ins. apart, instead of 8 ins., not a life would have been lost, nor a car nor span wrecked. To have done this, calling the bridge 400 ft. long, would have required the immense aggregate of something like 17.28 M. ft. B. M. more timber, which at $30 per M. might mount up to the heavy

Fig. 1
General View of Accident.

St. George Bridge Disaster; General View.

But passing these possibilities, what immediately began to happen when the derailed train struck the bridge was that the "needle-beams" were at once displaced and "bunched," leaving fearful gaps for the following wheels to bump over. The shocks produced by such blows, and by the broken coupling rod, might conceivably have destroyed the bridge by

it to break in two, the larger half remaining on the bridge and the lower half falling. Several in the car escaped.

7. DINING CAR.

Energy of motion destroyed, apparently in breaking off the rear end of parlor car ahead so as to fall on end in the position shown. Every person in it killed or injured.

The position of the wreck is, to our mind, proof

aggregate of $518.40. To save this paltry sum, half a hundred lives have been placed in imminent danger and 13 lost; millions who have passed over the bridge have been in possible danger; and $200,000 in money has now been lost, enough to give a proper floor in this detail to 400 such bridges. In view of this, it is certainly not too much to say that such

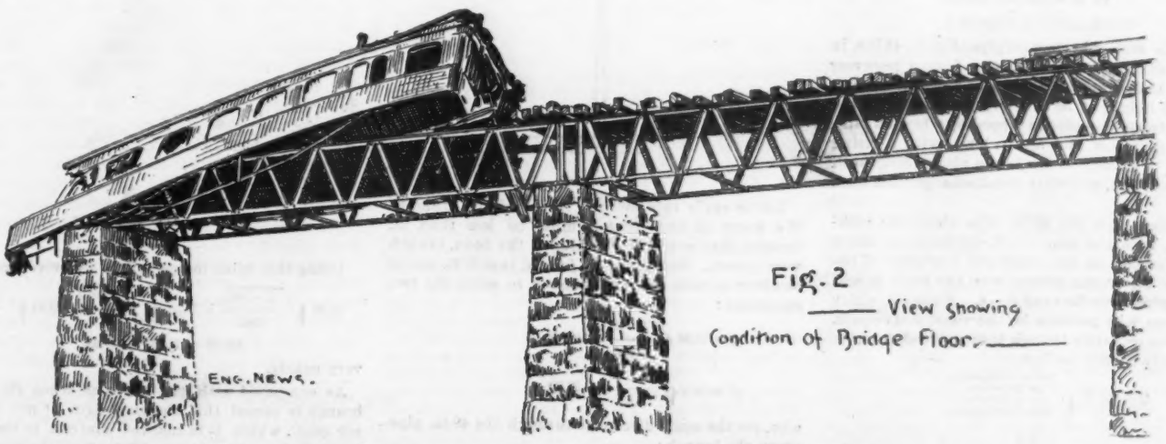


Fig. 2
View showing
Condition of Bridge Floor.

St. George Bridge Disaster; Showing Condition of Bridge Floor.

causing excessive strains, especially in such a light structure; but that the bridge was not destroyed in this way is evident from the fact that the engine, tender, baggage car, and smoking car passed entirely across in safety.

The passenger car also (the one furthest to the right on the ground) must have passed the span which finally gave way, in safety, as otherwise it would have struck the ground sooner. Its sad fate must have come merely from its derailment and not from bridge failure. The broken span undoubtedly gave way under the rear truck of the parlor car, the front half (or two-thirds) of which is seen in both views, still perched on the structure. The heavy weight of the following dining-car broke off the rear end of the parlor car, and the work of doing this so checked its own speed that it fell straight on end in the singular position shown, dropping its rear truck behind it through the demolished floor

positive (1) that none of the cars had wandered far from the track, and (2) that if the "needle-beams" had not been so widely spaced and so little bound together by guard-rails and otherwise as to be readily "bunched," nothing serious would have happened. The fate of the first-class coach may seem to indicate the contrary; but in all probability, as noted, this car first broke loose from the cars in front, and then was pushed by its own inertia and by the cars behind along the edge of some slanting needle-beam, or was diverted in the direction of least resistance for a twisted truck.

The coroner's jury distinguished itself as usual by the following lucid and intelligent verdict:

We also exonerate the railway company and their employés from any blame in the matter; but would respectfully recommend that the company cause all fast trains to slacken their speed when approaching the St. George station, especially east-bound trains.

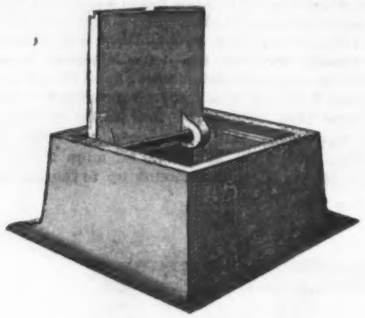
loose-jointed floors are quite as much a crime as a blunder, and quite as much a blunder as a crime. Yet in spite of such reiterated warnings, men will keep repeating them.

A CITY OF MEXICO LOAN of $12,000,000 for carrying out the drainage works, is advertised in the London financial journals at 85, interest being 5 per cent., redeemable at the rate of 1 per cent. per annum, by half-yearly drawings. It is stated in connection that the present population of the city is about 400,000 and rapidly increasing.

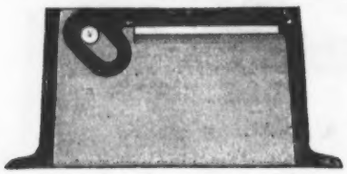
THE RIO GRANDE IRRIGATION SCHEME is the subject of a protest from the Mexican authorities. The claim is made that the diversion of water from the river will result in the ruin of Mexican towns along the river whose only industry is farming and who depend upon this water for irrigation. Mexico claims the first right to this water.

The Rodda Stop-Box.

The cast-iron stop-box here illustrated, is the invention of J. T. RODDA, of Eastbourne, England. It is very simple and can be readily opened without hammering even when rusted by long disuse. The



insertion of a bar into the wedge-shaped hole in the lid causes it to both slide and lift at one operation, breaking away any rust, and the dirt above falls in the box. The cover locks itself in closing



and there is consequently no danger of tipping from any load applied from above. This box is manufactured by the Engineering Appliances Co. of Eastbourne, England.

The Practical Calculation of the Heads, Diameters, and Discharges of Long Pipes.

BY E. SHERMAN GOULD.

(*Continued from Page* 188.)

Example 4th. A horizontal pipe (Fig. 7), 48 ins. in diameter and 2,000 ft. long, issues from a reservoir in which the surface of the water is maintained at a constant height of 50 ft. above the center of the pipe. Midway, this pipe is tapped by a branch pipe, 24 ins. in diameter and 500 ft. long, with a rising grade of 4 ft. in 500. What is the piezometric head h at the junction, and what the discharge from each pipe?*

It is evident that the 48-in. pipe above the junction must, with the head $50-h$, discharge as much water per second as the combined discharge of the 48-in. pipe below the branch with the head h, and the 24 in. pipe with the head $h-4$. From (3), which in this case will perhaps be the most convenient equation for quantity though that derived from (4) is frequently useful, we have:

$$Q = 12.56\sqrt{\frac{4\,(50-h)}{1000\times 0.00062}}$$

$$q = 12.56\sqrt{\frac{4\,h}{1000\times 0.00062}}$$

$$q' = 3.14\sqrt{\frac{2\,(h-4)}{500\times 0.00064}}$$

which, put in equation, give:

$$12.56\sqrt{\frac{4\,(50-h)}{1000\times 0.00062}} = 12.56\sqrt{\frac{4\,h}{1000\times 0.00062}} + 3.14\sqrt{\frac{2\,(h-4)}{500\times 0.00064}}$$

The coefficients 0.00062 and 0.00064 are so nearly equal that we may, in the following calculations, discard them as common factors. Dividing by 3.14 and striking out also the common factors $\frac{1}{1000}$ and $\frac{1}{500}$, we have simply:

$$4\sqrt{50-h} = 4\sqrt{h} + \sqrt{h-4}$$

*With these given lengths and diameters, the above system does not properly come under the classification of "long pipes." As the present object is only to exemplify methods of calculation, the example is equally good.—E. S. G.

Squaring:

$$800 - 16\,h = 16\,h + h - 4 + 8\sqrt{h^2 - 4\,h}$$

Neglecting, for a first approximate value of h, the quantities under the radical:

$$33\,h = 804.$$

Neglecting decimals:

$$h = 24.$$

Substituting this value for h under the radical:

$$33\,h = 804 - 8\sqrt{576 - 96}$$

which gives, always neglecting decimals, a second approximate value:

$$h = 19.$$

A third and fourth approximation give respectively $h = 20.3$ and $h = 20$.

We will take 20.1 as very near the true value.

Substituting 20.1 in place of h in the equations giving the quantities discharged, we have:

$$Q = 12.56\sqrt{\frac{4\times 29.9}{0.62}} = 174.45$$

$$q = 12.56\sqrt{\frac{4\times 20.1}{0.62}} = 143.05$$

$$q' = 3.14\sqrt{\frac{2\times 16.1}{0.32}} = 31.50$$

We have thus:

$$Q = q + q'.$$

The above method gives directly the true value of h; but it involves tedious figuring, even in our example, which happens to admit of many simplifications owing to the number of common factors. It will be easier, and often shorter, to obtain the value of h by first *assuming* one which we judge likely to be near the truth, calculating what discharge it would give from the two branches, and then calculating the head necessary to discharge the same quantity from the single pipe above the branch. Then, comparing the total height thus obtained with the known height of the water in the reservoir, we can deduce the true value of h by a proportion.

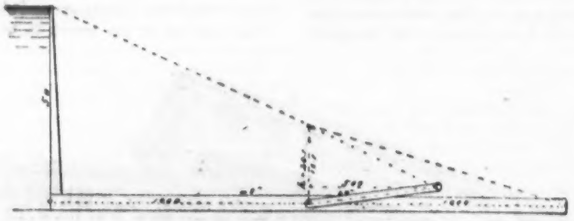


Fig. 7.

Let us apply this method to the above example. We know at once that h must be less than 25, because that would be its value if the 24-in. branch were closed. Supposing we judged that 22 ft. would be about correct. We then have to solve the two equations:

$$q = 12.56\sqrt{\frac{4\times 22}{0.62}} = 149.60$$

$$q' = 3.14\sqrt{\frac{2\times 18}{0.32}} = 33.30$$

also, for the equal discharge through the 48-in. pipe above the branch:

$$h = \frac{(182.90)^2\times 0.62}{(12.56)^2\times 4} = 32.87$$

This height, added to 22, the assumed value of h, gives a total height of 54.87 ft. as against 50 ft., the actual total height. By proportion we have:

$$\frac{h}{22} = \frac{50}{54.87}$$

This value of h agrees with that already found.

If the 24 in. branch were closed, we should have for the discharge:

$$Q = 12.56\sqrt{\frac{4\times 50}{1.24}} = 159.51$$

When the 24-in. branch was open, we had a total discharge of 174.73 cu. ft. per second. There is an increase, therefore, of about 9½ per cent. by opening the branch.

Let us now see what the discharge would be if the branch were placed only 500 ft. from the reservoir, instead of 1,000 ft., all the other conditions remaining the same.

We will assume $h = 33$ ft. and solve the two equations

$$q = 12.56\sqrt{\frac{4\times 33}{1500\times 0.00062}} = 42.3$$

$$q' = 3.14\sqrt{\frac{2\times 29}{0.32}} = 191.8$$

also

$$h' = \frac{(191.8)^2\times 0.31}{(12.56)^2\times 4} = 18.07$$

giving a total height of 51.07 as against 50. Reducing:

$$\frac{h}{33} = \frac{50}{51.07}$$

$$h = 32.3$$

Using this value, instead of the assumed one, we have:

$$12.56\sqrt{\frac{4\times 17.7}{0.31}} = 12.56\sqrt{\frac{4\times 32.3}{0.93}} + 3.14\sqrt{\frac{2\times 28.3}{0.32}}$$

$$189.83 = 148.03 + 41.76$$

very nearly.

As compared with the discharge when the 24-in. branch is closed, this shows a gain of 19 per cent., just double the gain when the branch was located at the center of the pipe.

Supposing now that the branch were placed 1,500 ft. from the reservoir. Assuming 10 ft. as a probable value of h, we have:

$$q = 12.56\sqrt{\frac{4\times 10}{500\times 0.00062}} = 142.46$$

$$q' = 3.14\sqrt{\frac{2\times 6}{0.32}} = 19.23$$

also:

$$h' = \frac{(161.7)^2\times 0.93}{(12.56)^2\times 4} = 38.53$$

By proportion:

$$\frac{h}{10} = \frac{50}{48.53}$$

$$h = 10.30$$

Using this value instead of the assumed one:

$$12.56\sqrt{\frac{4\times 39.7}{0.93}} = 12.56\sqrt{\frac{4\times 10.3}{0.32}} + 3.14\sqrt{\frac{2\times 6.3}{0.32}}$$

$$164.13 = 144.57 + 19.68$$

very nearly.

As compared with the discharge when the 24-in. branch is closed, this shows a gain of not quite 3 per cent., which is in marked contrast to the gain when the branch was only 500 ft. from the reservoir, being less than one-sixth of the gain, in that case.

It will be interesting to study a little more in detail the question of relative discharges. We have seen that when there is no branch open on the 48-in. pipe, its discharge is 159.51 cu. ft. per second. The 24-in. branches, wherever placed, increase the total discharge, but diminish that in the 48-in. pipe, below the branch. By comparing the above quantities, it will be perceived that the flow from the 48-in. pipe is diminished approximately by that proportion of the quantity flowing through the 24-in branch which is represented by its proportionate distance from the reservoir. Thus, when the branch is 1,500 ft., or three-quarters of the length of the 48-in. pipe from the reservoir, as in the last case, its discharge is 19.63 cu. ft. per second. Three-quarters of this quantity is 14.715, which, subtracted from 159.51, leaves 144.795, or very nearly that of the 48-in. pipe below the branch, as determined by calculation.

In the same way half of the discharge, when the branch is situated half way from the reservoir,

subtracted from 159.51, gives also very nearly the amount discharged below the branch. When the branch is 500 ft., or one-quarter of the total distance from the reservoir, one quarter of its discharge taken from 159.51 gives very closely the discharge as calculated for the 48-in. pipe below the branch.

Let us now take an extreme position for the branch, and suppose it placed closer to the reservoir, so that there is practically no portion of the 48-in. pipe between it and the reservoir .There will, therefore, be no part of the flow from the branch subtracted from that of the main pipe, and the two will each discharge the same quantity as if the other were not there. That is, the 48-in. pipe will discharge 159.51, and the 24-in. 53.24 cu. ft. per second.

If we should take another extreme position for the branch, and suppose it placed at the end of the

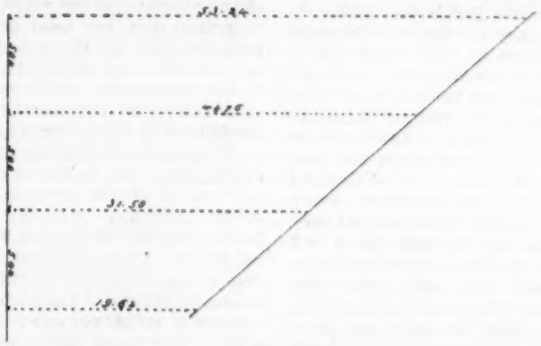


Fig. 8.

48-in. pipe, it is obvious that, with its assumed rising grade of 4 ft. in 500, it would discharge no water at all. A position could be found by trial where it would cease to discharge water, but for the object of the present investigation this is not necessary.

If the above results are plotted, as in Fig. 8, a very instructive diagram is obtained. The successive 500-ft. lengths being laid off as abscissæ, and the discharges measured upon the corresponding ordinates, it will be seen that their extremities all lie nearly in the same straight line. If, therefore, the discharges for any two positions of the branch be calculated, and a straight line drawn passing through their extremities, the discharge for any other position of the branch can be obtained by erecting an ordinate at the given point to the straight line, and the flow through the main also obtained by subtracting the proper portion of that of the branch.

In practice, when making calculations similar to those under consideration, one error must be carefully guarded against, namely, the supposing that the actual results will be exactly as calculated. The chief value of these calculations lies in the fact that they furnish quite trustworthy relative results, that is, they establish fairly well in practice the fact that if a certain pipe delivers a certain volume of water in a certain position, it will deliver a certain greater or less amount in another. The actual amounts, in either case, cannot be surely determined, as they depend upon so many varying circumstances about which, even when aware of their existence, we have no exact data.

(TO BE CONTINUED.)

Pennsylvania Railroad Rules for Condemning Wheels and Axles.

We have had several inquiries from engineers, especially foreigners, asking the meaning of the terms "shelled out," "comby," "seams," etc., etc., used in the Pennsylvania classification, and copied from that in the Report of the Am. Soc. C. E. Committee on the Form of Rails and Wheels, whose report we published Nov. 3 *et seq.* 1888. To answer these inquiries, and to inform others likewise about an excellent system which has now been used for inspecting several times more wheels, probably, than any other single system in the world, and which is also one of the most careful and complete, we reprint the substance of these regulations, omitting clauses of merely local value, adding likewise the rules for inspecting axles. The large variation which often exists in the diameters of wheels on the same axle is broadly indicated in the very first clause reprinted:

SEC. 1.—USING NEW WHEELS.

1. Strict attention must be paid to the mating size stenciled on inside plate of wheels, so that wheels differing more than one size shall not be placed on same axle, that is: Wheels measuring 112 may be mated with 111 or 113, but in no case with 110 or 114. To insure accuracy, each pair of wheels must be sized with wheel tape before mating.

2. The pressure at which wheels are forced on the axle must not be less than 20 tons nor more than 35 tons.

SEC. 2.—DISPOSAL OF SECOND-HAND WHEELS.

1. Second-hand wheels found good for further service must be remated in accordance with Par. 5, Section 1. Wheels showing a tendency to wear at the flange should be mated together. Also, wheels showing a tendency to wear away from the flange.

2. If a pair of wheels is removed from service, they should not be returned on the same axle, to the same or other service, unless both wheels size the same by the wheel tape.

3. Under no circumstances mate a second-hand wheel with a new wheel.

4. Second-hand wheels from Passenger Equipment Cars or from engines must not be transferred to Freight Cars if there is a probability of their running smoothly and giving further satisfactory service in the equipment from which they were drawn.

SEC. 3.—INSPECTORS' WHEEL REPORT.

The following terms must be used in reporting the condition of wheels drawn:

1. *Shelled Out.*—To be used when wheels become rough from circular pieces shelling out of the tread, leaving a rounded flat spot, deepest at the edge, with a raised center.

2. *Comby.*—To be used when flat spots occur, composed of a collection of small holes in the tread. Care should be taken to distinguish between defects Nos. 1 and 2.

3. *Seams.*—To be used when wheels show seams or cracks running lengthwise of the tread.

4. *Worn Flange.*—To be used when wheels show the flange worn thin so as to make them unsafe, either from breakage or tendency to mount the rail.

5. *Worn Flat.*—To be used when wheels have worn on tread so as to produce a flat spot. Do not confuse this term with "flat sliding."

6. *Worn Hollow at Flange.*—To be used when wheels are worn hollow close to the flange. This defect is often associated with Nos. 4 and 5.

7. *Worn Hollow from Flange.*—To be used when wheels are worn hollow on the tread, away from the flange, the wheel looking as if the flange seldom ran against the rail. Care should be taken to distinguish between this defect and No. 6.

8. *Burst.*—To be used when wheels are cracked from the wheel—fit outward, by pressure from the axle. *Length of crack should be stated.*

9. *Broken Flange.*—To be used when wheels are so broken. *State length of piece broken off.*

10. *Broken Rim.*—To be used when wheels have the outside of rim, opposite flange, broken. *State length of fracture.*

11. *Cracked Plate.*—To be used when wheels show a crack in the plate. *Give length and location of the same.*

12. *Cracked between Plates Outside.*—To be used when double-plate wheels show a crack in the hollow, where single and double plates unite.

13. *Cracked Brackets.*—To be used when wheels are so broken. *State number of brackets cracked.*

14. *Broken in Pieces.*—To be used when wheels are so broken that at least a portion of both the tread and flange is removed.

15. *Flat Sliding.*—To be used when wheels show flat spots, caused by undue application of the brakes.

16. *Good for Passenger.*—To be used when wheels drawn from Passenger Equipment Cars, or from Engines, are fit to be returned to the same service.

17. *Good for Freight.*—To be used in reporting wheels good for service under Freight Cars. No wheel, however, showing a defect that would impair its safety for Passenger service should be considered good for Freight service.

18. In reporting wheels, give the date of casting; also, state in addition to the defects, if any, whether the wheels are good for "Pass.," good for "Frt." or "Scrap."

19. Wheels often show more than one of the defects given above. In such cases report all the defects, giving the one which condemns the wheel the first place on the report.

20. Wheels may sometimes be condemned for other causes than those given above; for instance, they may be injured in a fire. In reporting such cases, the inspector will use such terms as will give a clear idea of the cause of removal.

21. A wheel showing a fracture of any kind should be condemned.

22. Inspectors must not allow a wheel to pass out of their hands until it is plainly marked with chalk or white lead, "Pass." "Frt." or "Scrap," to agree with weekly report.

23. General terms, such as Flat, Cracked, Rough, Worn-out, Good, etc., should not be used, and in no case will be received as a sufficient report.

[Clauses 24 to 31, omitted, relate to form of reports and other local details.]

SEC. 4.—AXLES.

1. The present practice of transferring Passenger Equipment Axles to Freight service when a maximum mileage is reached will be discontinued from this date, and the use of axles will be governed by the following table of "Journal and Wheel—Fit Limits":

Locomotive Truck Axles.	Journals.			Wheel-Fits	
	Standard Size.	Road Limit.	Shop Limit.	Standard Size.	Limit.
Passenger—Classes A anth. K. N. O. & P.	5 in.	4¾ in.	4¾ in.	5 in.	4⅞ in.
Passenger—Other classes	4¼ in.	4⅛ in.	4⅛ in.	4¼ in.	4⅛ in.
Freight—Classes I.	4¾ in.	4½ in.	4½ in.	4¾ in.	4⅝ in.
Freight—Other classes	4¼ in.	4 in.	4 in.	4¼ in.	4⅛ in.
Tender Truck Axles.					
Passenger,	3½ in.	3¼ in.	3¼ in.	4¾ in.	4⅝ in.
Freight,	3⅜ in.	3 in.	3⅛ in.	4¾ in.	4⅝ in.
Car Truck Axles					
Passenger,	3¼ in.	3⅛ in.	3⅛ in.	4¾ in.	4⅝ in.
Freight — 80,000 lbs. capacity.	3½ in.	3¼ in.	3¼ in.	4¾ in.	4⅝ in.
Freight — 40,000 lbs. capacity	3½ in.	3 in.	3⅛ in.	4¾ in.	4⅝ in.
Freight—Less than 40,000 lbs. capacity	3½ in.	2⅞ in.	3 in.	4¾ in.	4 in.
Freight—Short Journals (less than 7 in)		2⅝ in.	2¾ in.		4 in.

2. It will be noticed that there are two journal limits called "Road Limit" and "Shop Limit."

The "Road Limit" is for the use of Inspectors, who are hereby instructed not to allow any journal which to their knowledge has reached this limit, to remain in service, but to send car to shop, or report the locomotive to the round-house foreman, as the case may be, for change of axle. Inspectors will be required to *know* that no journal on which they have renewed the bearing has reached this limit, and they should take all other opportunities afforded, such as when boxes are responged, to look at and if necessary to measure the journals in order to guard against any journals which have reached the "Road Limit" remaining longer in service.

3. The "Shop Limit" for journals and the "Wheel-Fit Limit" are for the use of shop foremen and any persons having charge of the renewals of wheels and axles or shop repairs of any kind to trucks, and they will be required to *know* that no axle which has reached either of these limits shall be placed in service, or shall be allowed to go from shop into service, under any class of rolling stock for which either limit has been reached, but this does not prohibit the placing of axles which have reached the limit under one class of rolling stock, in service under another class whose limits are less.

SEC. 5.—INSPECTORS' AXLE REPORTS.

Inspectors in reporting axles will use the following terms to describe their condition: 1. Journal worn hollow. 2. Journal worn taper. 3. Journal worn too small. 4. Journal cut. 5. Collar worn thin. 6. Collar worn off. 7. Bent. 8. Journal broken. 9. Broken inside of wheel—fit. 10. When otherwise broken, state where and how.

PROFIT SHARING.—H. K. Porter & Co., of Pittsburg, Pa., locomotive builders, have made the second annual distribution of a percentage of the profits among their employés.

ENGINEERING NEWS
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D. McN. STAUFFER, A. M. WELLINGTON, EDITORS.

GEO. H. FROST. - - - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year;* $2.50 *for Six Months;* $1.50 *for Three Months; Single Copies,* 12 *cents.* FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Civil Engineers' Club of Cleveland, O.—Regular meeting March 12. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

New England Railway Club, Boston, Mass.—Regular meeting, March 13. Boston & Albany passenger station.

New England Water-Works Association.—Next meeting, March 13. Secy., R. C. P. Coggeshall, New Bedford, Mass.

Engineers' Club, Philadelphia, Pa.—Regular meeting, March 16. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, March 18. Secy., Kenneth Allen, 310 Baird Building.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, March 19. Secy., S. M. Wickersham, Penn Bldg.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, March 20. Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, March 20. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 20. "Street Car Running Gear," B. F. Crow; Reminiscences of the Construction of the Union Pacific Railroad," C. H. Sharman. Secy., Wm. H. Bryan, 709 Market St.

New York Railway Club.—Next meeting, March 21. Rooms, 113 Liberty St., New York City.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Apr. 3. Secy., John W. Weston, Gaff Building.

THE question of the proper form of bridge floors has been from time to time discussed in almost every aspect in these columns, but we feel it a duty again to call especial attention to the consequences of one very common, we might almost say standard, defect, as graphically illustrated in our views of the late St. George disaster, which appear elsewhere. It is, we are quite ready to admit, rather the rule than the exception to space bridge ties wide apart as they were on this bridge; usually 8 ins., and sometimes even more; but that it is a custom which would be more honored in the breach than in the observance, we think follows unavoidably from the facts of this fearful disaster, since it can be directly traced to the effect of a too open floor, and to nothing else. The escape of the front part of the train, and the slight deviation from the track of the rear part, amounts almost to demonstration that had the floor been solid enough to stand heavy banging, there would have been no wreck at all on the bridge.

The purpose of such wide spacing, of course, is to save timber, and only that, unless there may be some vague idea that it is desirable to have the ties wide-spaced to save trouble from snow. But the saving is so trifling, and the consequences in many cases so disastrous, that the real strength of this bad practice would seem to lie only in the fact that most engineers think little of what may happen after the road is built, but unconsciously assume that their duty is simply to provide for trains *on the track*, and that it is the operating officers' duty to keep the trains there, or take the blame for the consequences. At least, such apparent mental attitude seems to be broadly indicated by some other bad but common details of construction, like short ties on small structures, neglect of rerailing guards at bridges, etc. etc.

BUT the unfortunate fact is that trains do not and will not stay on the track always. For every one serious accident there are a dozen or two simple derailments or breakdowns and sooner or later there is sure to be some such occurrence on every structure or every mile. The only track in the world on which this danger is fully admitted and provided for is on the 50 miles or so of elevated railway in New York and Brooklyn, every foot of which is protected by a double heavy guard-rail for each rail, leaving only 2 or 3 ins. play for the wheels. Great has been their reward. Again and again have they had derailments or collisions at various unexpected (of course) points, but in no case have any serious results followed, as a direct and evident result of this ever-present protection. A like continuous protection is not to be expected on surface roads, and perhaps even when they pass over bridges it may not be expedient to have it as heavy and complete; but surely it is not too much to demand of every cautious man that he shall make a floor so nearly solid and continuous that derailed wheels will have a fair chance to go over it without such results following as are shown in our Fig. 2 on another page. No structure with the ties on it spaced 8 ins. apart affords such a roadbed.

THE Chicago *Tribune* is so excellent and ably edited a journal, and it is so seldom that it takes other than a high and honorable stand on questions of public interest, that we are sorry to note that of late it seems to have become seriously infected with "Railwayphobia." It loses no opportunity to attack the railway corporations, and to countenance the efforts of those legislators who are trying to cut down railway revenues; and not content with this, it is doing all it can, which we believe is not much, to defeat the present movement toward securing harmony among the Western railways in order that the disastrous experiences of 1888 may not be repeated this year.

The *Tribune* has shown such especial annoyance at each step in the formation of the Interstate Railway Association, or what it calls the "gentlemen's agreement," as to almost suggest that it is interested on the "bear" side of the stock market.

This cheap sort of talk takes a still worse form in a recent editorial entitled, "Two Kinds of Railway Management," which purported to draw a contrast between the management of the Atchison, Topeka & Santa Fé and the Chicago & Alton systems. The burden of the article lay in assertions that the former system was loaded down with watered stock, to which all its present financial troubles were due. We quote as follows:

> As the bonds [of the Atchison] represent all the capital actually invested, and the stocks are only "sugar" thrown in to sweeten the sale of them to investors, the failure of the company to pay dividends on chromos is calculated to give a false impression. If the Atchison system was called on to pay revenues only on the capital actually invested and was not loaded down with watered stocks, it would be in a flourishing condition and command high credit.
>
> . . . . . .
>
> Last year the Alton paid all its fixed charges, a dividend of 8 per cent. on its stock, and had a surplus in the treasury of over $300,000. The Alton Road is properly capitalized—its stocks and bonds are honest and genuine, representing capital actually put into the treasury of the company. The property is managed according to correct business principles by capable, conservative, and trustworthy men. The Alton Road is managed for traffic and earnings, not to float bonds or promote stock watering or Wall Street gambling operations. It has not built or bought branch lines for speculative purposes.

IT will be seen that the *Tribune* declares that the stock and bonds of the Chicago & Alton represent capital actually owned by the company; that is to say, the total stock and bonds of the company, at par value, it believes to be no greater than the total amount which has been expended in the complete construction and equipment of the road and which is now in use in carrying on its operations. Now, according to the last issue of *Poor's Manual*, the Chicago & Alton company's balance sheet shows a total capitalization of $39,443,205 upon railway lines with an extent of 849 miles, or at the rate of $46,458 per mile. By the report of the Atchison Company just issued, its total capitalization is: stock, $75,000,000; bonds, $47,933,000. This capitalization is on railways with a total extent of 7,121.52 miles. Hence the capitalization of the Atchison system is at the rate of $17,257 per mile. If, as the *Tribune* alleges, the bonds alone represent the actual cost of the Atchison properties, then they must have cost the small sum of $6,732 per mile! It should be said that the contrast is not quite so strong as this, for there is large amount of stocks and bonds of lines controlled by the Atchison held outside the Atchison company; just how much, the report before us does not state. But the amount is at any rate too small to alter the fact which we wished to point out,—that the Atchison system is far from being over-capitalized in comparison with other roads of the West.

It is a most commendable rule of procedure not to hit a man when he is down; and because the Atchison system, for reasons quite apart from its managers' actions, is now under a financial cloud, is a very good reason why its managers should *not* be unjustly accused of sins of which they are most evidently not guilty.

A PROMINENT engineer sends us, in a personal note, the following significant expression of views as to the American Society of Civil Engineers. While we must not be understood as endorsing it, or as giving any opinion in regard to it, it does, we know, voice a sentiment of discontent which is becoming widespread. Some of the views expressed in this communication we should, if we were to discuss them at all, dissent from decidedly, but to others we should as emphatically assent. It is idle to deny that the Am. Soc. C. E. does not now stand on the permanently satisfactory basis of the Inst. C. E. in London, and it will be greatly for its welfare if a sufficiently large body of its members recognize this fact in time. To mention only one matter, to which we have had occasion to allude in a practical way very recently, the manner of nominating and electing officers, and the size and composition of the governing body when elected, is such as to inevitably throw the practical running of the Society into the hands of a mere handful of members, if it is to be kept running at all; and when things under these conditions are, in the opinion of a large body of members, going wrong, it necessitates a more or less irregular and unpleasant movement in opposition to give expression to their views, and so bring out the real feeling of the Society, which ought to have an established opportunity for annual expression.

OUR correspondent remarks:

ENGINEERING NEWS has evidently worked hard to push the American Society, but, as you are well aware, many engineers consider it the only obstruction to a real national organization that exists in the country. It is organized on a purely local basis, and can never become national with its present organization. And the majority of its members, who control its action, show no symptoms of wishing to make it so.

It is true that the effort inaugurated some years ago for a partial Federal organization of the local engineering societies, has not developed as rapidly as was then hoped. It, however, has grown surely and is on a solid basis, more so than ever; and, what is of more importance, it has cultivated a sentiment in favor of an organization different from the Am. Soc. and it is sure to come. I shall not be surprised if it comes soon and suddenly, and when it does come it will come to stay. Many of the most prominent members of the Am. Soc., in the West particularly, ... are now advising a convention to take up the matter, and I hope it will find earnest support in the East; in fact I know that it will. It is quite likely that the movement will be inaugurated by the Association requesting all societies in the country, not only those belonging to the Association but those outside of it, to participate in a convention, for the organization of a Federal union. If the spirit that dominates the Am. Soc. was not narrow and pretentious, it would co-operate in such a convention and the result would be something that the engineering profession of the country could be proud of, which they cannot now be, in the true sense, of any existing organization.

A CORRESPONDENT writes us;

In all the Am. Soc. C. E. proceedings there is only one paper (DE VOLSEN WOOD'S, Vol. III) on back-water from dams; and in none of the Am. Soc. C. E. or Inst. C. E. papers is there anything on the partition of water power. Do you know where anything valuable is to be had on either of these subjects?

Every phase of the latter subject has probably been studied at Lowell, Mass., more carefully than anywhere else in the world, by investigations under the charge of JAS. B. FRANCIS, whose "Lowell Hydraulic Experiments," and various reports on the subject (many of which, we fear, are now out of print) must very nearly cover the subject. There has been a great amount of other valuable work of the same kind done elsewhere in New England, and not a little in California. We are unable without considerable investigation to give our correspondent the specific references he desires, nor probably with any amount of investigation could we do so as completely as can some of our readers who have made a special study of such matters. We shall be obliged if any such will forward us more in detail the information asked for.

Varying Ideas about Rail Sections.

Before we were able to complete what we had to say* about Mr. DON J. WHITTEMORE'S proposals that the heads of all rails should be made flat (beyond what was necessary for a short corner radius) it has come about that we are ready to present, as we do on another page, a variegated assortment of the ideas of other people in regard to rail sections. All these ideas come from men who ought to know, whose business and whose duty it is to know, what form of section will give best service. How little they have been able to agree among themselves is at once apparent from the sections; and it is certainly a significant fact—or if not that, it is at least a curious coincidence—that almost the only single detail in which they are able to agree is that about a 12-in. radius, or a little less, is about the proper thing for the head of the rail! Out of the 19 sections, 14 have this radius, and the other 5 what is practically the same thing only "a little more so," a 10 to 10½ in. radius.

We are far from regarding this agreement as conclusive; the designers may easily all be wrong on the one thing that they agree in. But on the other hand it must in candor be admitted that such coincidence of judgment as to one detail, after the very great amount of study which rail sections have had from many different men of many different minds about everything else connected with rails, does throw a very strong burden of proof upon any one who asserts that in the one direction in which they have heretofore agreed there was no trouble to be looked for, lies the whole of the trouble. Under these conditions it is surely incumbent to prove by direct evidence (1) that there is a cause in the neglected direction sufficient to explain the unfortunate results; (2) that these results are not explicable otherwise; and (3) that the proposed new form of rail will avoid these results.

The last would probably follow if the first two were granted, but the first two we are compelled to hold that Mr. WHITTEMORE has wholly failed to prove. What he may be admitted to have proved is, that the customary crowning of the top of the rail can hardly be doing much good, and is exceedingly likely to do some harm at least, so that, if there be any crowning at all, it should be very slight. But we have too fresh a remembrance of the great harm that was done by DR. DUDLEY'S supposed discovery that to have a rail wear well, it ought to be nice and soft, to wish to see some second turning aside from the real issue to follow what might prove, and according to our best present understanding would prove, a mere will-o'-the-wisp, differing from DR. DUDLEY'S in doing no harm, but resembling it in leaving great errors of practice to go on unchecked. We are not, as at present advised, opposed to Mr. WHITTEMORE'S flat-top rail; we are inclined to favor it: but what we cannot believe on the evidence submitted is that it will make any important or appreciable difference either way, all other things being equal.

For of what does this evidence consist? It consists, *first*, of a very valuable and carefully collected body of facts going to demonstrate what well-informed men were pretty well satisfied of before, that the heavily loaded drivers do the great bulk of the damage to rails and tires, leaving the much greater tonnage of cars to do much less aggregate damage. This must be at once granted, as also the further conclusion that it is not abrasion but deformation of section at and near to the joints which causes the failures of most modern rails. But there are many causes which may contribute to promote this latter, one of which at least affects the question of section in an entirely different manner, and is evidently regarded as very important by most of the designers of the sections elsewhere illustrated, viz., that the rails are rolled *too hot*, especially when the head is disproportionately heavy, and hence that so little work is done by the rolls on the thicker parts of the section as to leave them spongy and, so to speak, "rotten." All the examples of split or otherwise defective rails with which Mr. WHITTEMORE accompanies his paper (see p. 159 of our issue of Feb. 23) seem to us to owe their defects chiefly to this cause, beyond doubt, and in no sense to the effect of loads imposed after manufacture. Certainly, positive proof, admitting of no other interpretation, is required to prove the latter.

The positive proof submitted by Mr. WHITTEMORE as to the bad effect of curved tops is:

(1) Experiments made by him, supplementing similar ones make by Mr. O. CHANUTE in 1876. The latter showed that the insistent loads per square inch varied from 26,607 to 85,961 lbs., 5 out of 16 tests showing over 75,000 lbs. per sq. in.; 3, 60,000 to 75,000 lbs.; 1, 58,333 lbs.; 2, 40,000 to 50,000 lbs., and 5, 26,607 to 35,594 lbs. The average of the 16 tests is 57,680 lbs. per sq. in. Mr. WHITTEMORE adds two tests of his own, each the average result of a series of tests; the first average showing 16,000 lbs. on 1.7 sq. in., or 9,412 lbs. per sq. in., and the other, 13,800 lbs. on 0.86 sq. in., or 16,047 lbs. per sq. in., being greatly less than Mr. CHANUTE'S results.

(2) In proof that these pressures are so excessive as to be destructive to the metal by crushing, Mr. WHITTEMORE submits a formula by Prof. FREDERICK GRASHOF, of the Polytechnic School at Carlsruhe, "one of whose formulæ has been extensively used in this country for determining constants for rollers on plane surfaces in nearly every first-class bridge specification for many years." Using a modulus of elasticity of 29,000,000 and 30,000,000, based on Mr. CHRISTIE'S experiments, Mr. WHITTEMORE deduces that by Prof. GRASHOF'S formula, with an elastic limit of 40,000, the safe load on a 70-in. wheel, resting on a rail top of 12 ins. radius, is only 7,008 lbs. (see table in our issue of Feb. 16, p. 142), whereas a flat-top rail, by the same formula, would sustain 23,243 lbs. without exceeding the elastic limit, or over three times as much.

Now, relatively, we see no reason to question the approximate correctness of these results. They are in accordance with reason and theory; but as regards the *absolute* values given we fail to see how they can be regarded as entitled to any great consideration. In the first place, it does not appear that the formulæ rest on any direct experiment with such curved surfaces, and the limit of elasticity especially is probably very different when load is applied to the center only of a large surrounding mass from what it is when it is applied uniformly to the entire mass, as in CHRISTIE'S experiments. No man is justified in making so large and dubious an assumption as the existence of such equality, and then asking the profession to believe that poor rail wear is due to these tabular values being exceeded because of the form of the rail top. The true method is *to determine by experiment the actual limit of elasticity under the actual conditions* by loading a wheel on a rail until it really causes permanent set by producing a dent, exaggerating the conditions of practice somewhat, but leaving them similar if not equal. We are greatly mistaken if the elasticity limit K, under these conditions, will not be found several times higher than it is under Mr. CHRISTIE'S wholly different conditions, and as the safe load varies as K^2 it will be seen how greatly any difference of this kind is likely to affect the result. We can, moreover, assert positively from a personal test that the heaviest locomotive driver resting on one spot of a new rail for a day or more is not able to produce an indentation which a ray of light will detect; and if not under such conditions, how much less when the engine is in rapid motion. For bridge rollers, Prof. GRASHOF'S formula is no doubt a safe and sound one, but the conditions are so wholly different that it would seem as if no formula found for such a purpose could likewise be found for use in designing rails. The bridge roller is (1) of very small diameter, (2) continuously loaded, (3) rotated with extreme slowness and back and forth through a small arc, and (4)—and above all—is so small and cheap an affair that there is no reason or excuse for not making it of ample size for all emergencies.

With rails and wheels it is far different, and therefore we submit that it is not reasonable to ask engineers to accept a German professor's dictum about the one as gospel likewise for the other, even if he did say, as we believe he did, that it might be extended to that use without direct experiments, when direct experiment is so easily possible. The tendency of German professors to push theory to the utmost is well known, and we are quite ready to believe that Prof. GRASHOF may be, as Mr. WHITTEMORE describes him, "one more astute than the celebrated character in Hudibras,

*ENGINEERING NEWS, Feb. 16, 1889.

Who could distinguish and divine
A hair, 'twixt south and southwest side,
And wisely tell what hour o' the day
The clock does strike by algebra."

But that kind of astuteness is not exactly what is wanted. We want experimental facts. We want *the proof* that 7,008 lbs., or twice or three times or four times or five times that load, placed on a 70-in. wheel resting on a 12-in. radius rail top for any length of time, will produce a permanent set. We have no belief that it will, although it does not admit of doubt that it will take a less load than it will to produce permanent set in a flat rail loaded *exactly evenly* with a flat wheel.

But exactly even loading is a thing not easy to obtain; and there are these arguments against a perfectly flat top which have not yet been noted: (1) Unless with rail and wheel tread exactly horizontal or equally inclined, the bearing will be on one edge of the rail or the other in any case. (2) An equal load will do much more damage under these conditions than if similarly applied at the center. (3) The worn surface must be horizontal as well as the original top, or the original flatness will soon be lost. Our impression is that the rails would wear slightly crowning in any case, as they do now (the play of the wheel alone would tend to provoke this), and that it would be impossible to cause an effective bearing over more than ¼ in. to 1 in. laterally. In addition we have (4) rails now near to, and permanently retaining about a 12-in. top radius, as shown by the section taken by Mr. THOS. RODD, of the Committee on Form of Rails and Wheels, published in ENGINEERING NEWS of Oct. 8, 1787, and republished in the Committee's report, pages 38 39. As rail and wheel wear inevitably tends to wear off those parts most which sustain disproportionate loads, it seems to us an unavoidable conclusion that with a 12-in. rail top, every part of the head is about equally loaded and worn, for it is notable that the top curve of all the worn rails is almost exactly symmetrical relatively to the axis of the rail.

The conclusions to which we seem to be led are therefore: (1) that the actual wear or loss of metal from rails and wheels may all be explained as coming from abrasion or rubbing, but is not the cause for the removal of most rails; (2) that deformation of section results chiefly from defective material or manufacture and is not aggravated or materially affected by the precise form of the top of the section; (3) that cracks and breaks are still less affected by this cause, whence it follows (4) that no change in the top curve of rails can materially benefit or affect existing conditions: it is certain in some ways to do some good but likely also in other ways to do some harm.

That these are the views to which the majority of designers are coming is strongly evidenced by the sections which appear elsewhere, the predominating tendency in those most carefully studied being to reduce the disproportion in thickness in the various parts of the rail. The facts of the designs, briefly analyzed, are as follows:

The proportion of metal in the heads ranges all the way from 39.1 to 52.0 per cent. There are with:

39.1 to 41.8 per cent. in head	5
43.6 to 44.2 " "	2
46.1 to 49.8 " "	10
51.9 to 52.0 " "	2
	19

The adopted Michigan Central section has 41.8 per cent. of its metal in the head, being thus much smaller in the head relatively than 14 out of the 19 sections. Even the English bull-head section has 47.1 per cent. of its metal in the head.

The rails which have the smallest heads have for the most part the thickest neck, and *vice versa*. Thus, to take only the extreme of the above table, the four rails with largest heads run in order of size:

	Head.	Neck.	Base.
	52.0	17.1	30.9
	51.9	16.5	31.6
	49.8	16.8	33.4
	49.3	18.4	32.3
Average	50.75	17.20	32.05

On the other hand, the five rails with smallest heads run in order of size:

	39.1	22.9	38.0
	40.1	22.9	37.0
	40.3	21.5	38.2
	41.8	21.8	36.4
	41.8	21.9	36.3
Average	40.62	22.20	37.18
Difference	−10.13	+5.00	+5.13

The plain object in the "big head" designs is to get all the metal possible in the head, with the idea that the metal to be worn away, and the consequent life of section, is thereby increased. The effect is to make the head very much bigger than any other part, hence to keep it very much hotter in the rolls, and to leave the rolls to expend comparatively little work on it.

The plain object of the light-head ections is to remedy this state of things so far as possible, making the head smaller and the base larger, and making the neck likewise thicker so that it may not cool so quickly. It is evident that the effect must be to make the whole rail of a much more nearly uniform temperature when it leaves the rolls, and hence to expend much more work upon the head. In this direction we believe there is great chance of good results; in shaving a thin film off the now usual top, not much chance of a perceptible effect of any kind, good or bad.

The Water-Works of the North Central States.*

II.

Table 8-E, showing cost and revenue per head, tap, etc., gives the fairest basis of comparison of the States and groups thereof, and in this Indiana's rank is low. Its investment per head in water-works is among the smallest in the Union, only two of the Southern States falling below it, most being far above; its works are likewise among the cheapest, as shown by the cost per mile of main. No Southern State, and in New England only New Hampshire and Vermont, which have many small works, fall so low in this item. As a natural consequence of this fact the population per tap is very high, 17.6—more than double the average for the group—indicating that only a small portion of those potentially supplied actually use the water. The seeming paradox of many "floaters" and little water, to which we have already alluded, we leave every one to explain for himself. Compared with Ohio and Michigan, Indiana's revenue from its water-works is good, but the revenue per head and mile of main is low. Indiana is also by far the most backward State in the group in respect to the use of meters, although the group as a whole uses fewer meters than any of the other groups, as will be seen from the last four lines of the table. One does not gather an altogether favorable opinion of Indiana as a progressive State from these statistics, nor from some which follow.

Taking the groups as a whole, the cost of works per head is quite uniform at $23.50, New England being high at $35.30. The cost per mile of main is cheap in the North Central group ($13,780 against $16,080 to $21,000) doubtless because of the absence of costly reservoirs and conduits. The cost per tap is highest in the Southern States and New England ($283 and $269) and lowest in the Middle group ($176 against $197 in the North Central). The revenue per head is singularly uniform in all the groups ($2 to $2.66); the revenue per tap ($16.90 to $25.30) lowest in the Middle States and highest in the South, and the total revenue per cent. highest in the North Central group, 9.72 per cent. against 9.40 Middle, 8.93 Southern and 7.54 New England.

Table 9-E shows a somewhat striking contrast in respect to kind of works. There are only 16 gravity works out of 331, or 4.8 per cent. in the whole group, against 13.1 per cent. in the South, 42.4 per cent. in the Middle, and 50.4 per cent. in the New England States. Indiana has no gravity works and Michigan and Illinois only 5 between them. Direct pumping works here first become the predominating type, and works pumping to reservoir the rare exception. The broad contrast between the sections is shown in the following table, which concerns pumping works only.

Per cent. of works pumping to	*Reservoir*	*Tank.*	*Stand-Pipe.*	*Direct.*	*Total*
North Central	14.8	16.5	23.2	45.5	100.0
Southern	32.4	22.2	31.5	13.9	100.0
Middle	49.8	14.1	18.9	17.2	100.0
New England	40.6	17.1	25.2	17.1	100.0
Michigan	9.8	7.3	7.3	75.6	100.0
Illinois	13.8	34.5	27.6	24.1	100.0

The two States given last illustrate the extremes of the North Central group. Michigan has hardly any but direct pumping works; Illinois chiefly tanks and stand-pipes. Why this should be, we cannot explain. It is notable that in Illinois nearly all the direct pumping works are of old date. Before 1880 14 out of 27 pumping works were direct; since 1880 only 7 new pumping works have been built against 53 works pumping to reservoirs, tanks or stand-pipes. The same tendency is visible in Wisconsin. Indiana continues to favor direct pumping, and so does Michigan.

The sources of supply, shown in Table 10-E, likewise show a very marked contrast. Not less than 41.5 per cent. of the works depend on wells for a supply, largely artesian wells. Some of these wells are only 400 ft. deep; the deepest, 2,000 to 2,510 ft., so far as our records show. Wisconsin has no less than five "gravity" works supplied from wells without pumping, the wells flowing out under pressure so as to give in one case 43 lbs. per sq. in. pressure, in the mains. There are two or three other such works in other States of the group.

Surface supply is hardly used at all in this group, and springs very little, only 12 per cent. of the works depending on either, against about 36 to 33 per cent. in the other groups.

The lake supplies are numerous only in Michigan and Wisconsin, and more than half those classed as lake, draw from the Great Lakes. Of brook supplies, there is not a single one, for the good reason that there are few or no brooks in this region fit for water supply. Only in a hilly region are brooks sufficiently pure and constant. Rivers and creeks supply about one-third of the works in all the groups but New England.

The average working pressures, shown in Table 11-E, range somewhat lower than the average of other sections, the larger number being between 40 and 50 lbs. The fire pressures, Table 12-E, are some of them very high. A much larger total of works than in any other section are arranged to give higher fire pressures, 198 out of 310 pumping works reporting such, while it is quite certain that many of those which do not specifically report fire pressures really have a higher one. The bulk of the fire pressures are between 70 and 130 lbs., but a large number run from that to 200 lbs. The excess above normal pressure ranges from 30 to 90 lbs. for the most part; but Canton, Ill., for example, ranges from 38 working to 200 lbs. fire pressure.

Table 13-E, showing the ownership of the

*Our previous reviews for other sections were published: New England, Oct. 13-20, 1888; Middle States, Dec. 15-22, 1888; South Atlantic and South Central States, Feb. 9, 1889.

works, shows likewise some striking contrasts. No group gives such a heavy per cent. of public works as this, as shown in the following comparison, the "population" spoken of being the 1880 population of the present water-works towns:

	No. Cen.	So. Atl.	So. Cen.	Mid. dle	New Eng.
Per cent. public works, by no.	64.5	56.3	23.6	33.5	41.4
" " by pop'n supplied	74.6	64.4	21.5	78.3	72.3
Pop'n per private works	6,485	6,900	13,080	4,930	3,980

Indiana compares badly with the other States of the group, in this as in other details; 55 per cent. of its water-works population has had to trust to private enterprise for water against only 15 per cent. in Ohio, and 18 per cent. in Illinois. Indianapolis is, with two exceptions (San Francisco and New Orleans), the largest city on the continent which has trusted to private enterprise for its water-supply, and there are several other large towns so supplied. Michigan is conspicuous for the number of small public works, leading all the States so far reviewed in all the groups, very largely. Wisconsin has trusted extensively to private enterprise, and especially to outside companies, having an unusually large number of the latter. The number of *de facto* outside companies is larger in all the States than is indicated by our returns, however, the name only being local sometimes, while the works are really controlled as an outside investment. A strong argument may be made in favor of small towns trusting to private enterprise for water-works, as really cheaper for them, but the same can hardly be said of large works.

In use of meters, Table 14-E, this group is backward, as we have noted. There are only 6 towns in the whole group, with as many as one-sixth of their taps metered, and only one of these is a large place. Most of the large cities have but very few meters.

Hydrant rentals, Table 15 E, range high. The most common rate is $75, and the average decidedly higher than in any of the other groups. The general average is somewhat over $55.

The different kinds of pumping machinery are shown in Table 16-E. As is to be expected, the aggregate pumping capacity is very large, aggregating 1,167.3 millions of gallons daily capacity, against 366.1 in the South Atlantic and South Central groups, 981.2 millions in the Middle group, and 342.1 in New England. The extent to which the selection of makes of pumps is influenced by merely local causes or examples is very notable. Thus, the Walker pump is one generally used in Michigan, but not appearing at all in any of the other States. Possibly there may be some Walker pumps included among the "miscellaneous" of other States, from the make not being specified, as under that head a considerable variety of pumps are included, such as water-power pumps, large pumps of local design, or by other than regular pump-makers, pumps of unknown or unreported makes, etc.

			Bl.	Davis	Deane	Kn.	
351.1	145.0	276.8	51.5	3.0	85.0	62.4	1167.3
20.5	87.4	81.0	38.4	5.0	43.2	18.0	366.1
262.2	344 6	156.9	26.1	28.7	19.4	32.1	981.2
62.9	123.8	17.5	21.4	12.5	39.5	19.5	342.1
746.7	700.8	532.2	137.4	49.2	187.1	132.0	2,856.7

The Holly-Gaskill pumps have a large lead in this group, 108 pumps with 276.8 million gallons' capacity against 85 Worthington pumps with 145.0 millions gallons. In all the five groups so far reviewed, however, which include practically all the States east of the Mississippi River, the totals are:

	Million galls. daily capacity
Worthington	760.8
Holly-Gaskill	532.2
Deane	187.1
Blake	137.4
Knowles	132.0
Davidson	49.2
Other smaller makers	371.3
Miscellaneous	746.7
Total, east of Mississippi River	**2,856.7**

TABLE 8-E.

NORTH CENTRAL STATES WATER-WORKS.—COST AND REVENUE PER HEAD, TAP, MILE OF MAIN, ETC.

STATE.	Cost per			Revenue per			Population on water works.		P. C. rev. to cost.
	head on water-works.	mile of main.	tap.	head on w'ter w'ks.	mile of main.	tap.	per tap.	per meter.	
Ohio	$27 40	$17,800	$268	$2.16	$1,402	$21.20	9.8	225	7.87
Indiana	15.38	10,720	272	1.32	1,002	25.30	17.6	730	9.33
Michigan	22.90	10,240	163	2.00	895	14.22	7.1	511	8.73
Illinois	21.27	12,840	137	2.62	1,555	16.84	6.4	200	12.31
Wisconsin	24.68	15,030	295	2.14	1,614	31.68	12.0	194	10.74
Av. No. Cent	$23.10	$12,780	$197	$2.24	$1,328	$19.18	8.5	280	9.72
do. Southern	$22 80	$17,180	$283	$1.04	$1 533	$25.30	12.4	224	8.93
do. Middle	25.40	21,000	176	2.43	2,023	16.90	6.9	181	9.40
do. New Eng	35.30	16,080	269	2.66	1,213	20.30	7.6	63	7.54

TABLE 9-E.

NORTH CENTRAL STATES WATER-WORKS—KIND OF WORKS.

STATE	Gravity	Pumping to				Unkno'n	Total	P. C. gravity works
		Reservoir.	Tank	Stand-Pipe	Direct			
Ohio	5	15	7	19	23	2	71	7.0
Indiana	.....	7	4	11	21	.....	43	0.0
Michigan	2	8	6	6	62	1	85	2.4
Illinois	3	12	30	24	21	1	91	3.3
Wisconsin	6	4	4	12	14	1	41	14 6
Total N. Central	16	46	51	72	141	5	331	4.8
do. Southern	17	35	24	34	15	5	130	13.1
do. Middle.	175	116	23	44	40	4	412	42.4
do. New Eng	130	50	21	31	21	5	258	50.4

Some of the works have a double system which increases the total. Several gravity works have small auxiliary pumping systems for special service which have been disregarded. Most of the pumping works pump direct in case of fire.

The Deane pump is very much used in all the North Central States, in two of them leading the Worthington. The latter leads the Holly in Ohio only, and in Indiana, Michigan, and Wisconsin is little used, while in Illinois it is a very good second. Why such noticeable differences should occur in contiguous States is a conundrum which we cannot guess.

It is notable that most of the large cities, including all the very large ones of this group, have most or all of their pumps specially designed for them, and do not patronize any of the well-known builders. In part, the reason for this is easily understood.

The dams and reservoirs in this group are few and mostly small affairs. The most extensive dams are, a stone dam from Moline to Rock Island, built by the U. S. Government, 4,000 ft. long, 20 ft. high, 8 ft. wide at base, and 4 ft. wide at top, and a dam at Cincinnati only 1,251 ft. long, but 119 ft. high, 22 ft. wide at top, and 48½ ft. wide on the base. There is a 200,000,000 galls. reservoir capacity at Cincinnati and 118,000,000 galls. at Cleveland; but for the most part reservoirs are dispensed with throughout the group, for the very good reason often that there is no site to put one on.

The only tunnels of any importance are those run out under the shores of the Great Lakes to get water free from shore pollution. Of these there is an increasing number. The most important ones are, two at Cleveland, about 1¼ miles long each, and of 5 and 7 ft. diameter, the last built in 1888 and having a capacity of 115,000,000 galls. daily; three at Chicago, of 2 miles, 6 miles, and 4 miles length respectively, and 5 and 7 ft. diameter; and one at Hyde Park, Ill., 1¼ miles long and 6 ft. diameter. Another one, 6,000 ft. long and of 9 ft. diameter, is proposed at Lake View, Ill., and before long there will probably be several others. Many towns, like Milwaukee, are now relying on pipes laid out under water. At Bay City, Mich., there is an interesting and successful wooden conduit of this kind, over 4 miles long and 30 ins. diameter, made of pine staves 3 ins. thick and 4 to 6 ins. wide, in 8-ft. sections, as more fully described in our account of the works. As a whole, the water-works of the North Central States are highly creditable to them, and ten years hence will be still more so.

The New Ohio River Bridge and Railway Terminals at Wheeling, W. Va.

The extensive works which are now in progress at Wheeling, W. Va., on a railway bridge across the Ohio river and extensive terminal tracks, have been briefly noted in our news columns from time to time, but are described more fully in the following article, for which we are indebted to Mr. JOB ABBOTT, Chief Engineer of the company which has undertaken the work.

The Wheeling Railway Bridge and Terminal Company is the same corporation, under a new name, as the Wheeling and Harrisburg Railway Co. of West Virginia, which was originally organized as a part of the South Pennsylvania scheme, giving that line an outlet across the northern neck of West Virginia to and across the Ohio river, at Wheeling, W. Va.

This charter has been taken up by a party of Eastern capitalists, in no way connected with any particular railway company, for the purpose of building a railway bridge over the Ohio river, and terminal facilities in Wheeling, W. Va., and Martin's Ferry, O., to give ample and equal connections to all railway lines terminating on either side of the Ohio river at these points.

Among those interested in this enterprise are Capt. J. B. THOMAS, of Boston, Mass.; Col. GEO. P. BISSELL, of Hartford, Conn.; GEO. RIPLEY and R. H. STEARNS, of Boston; JACOB ROGERS, of Lowell, Mass.; and HENRY E. RUSSELL, L. B. HAWES, CHAS. M. FRY, and others, of New York City. Col. GEO. P. BISSELL is President, with office in Roger's Block, Wheeling, W. Va.

The contract for the grading, tunnel work, masonry, ballast, and tracklaying for the entire line has been let to Paige, Carey & Co., contractors, No. 45 Broadway, New York City. The contract for the Ohio river bridge and its approaches has been let to the Edge Moor Bridge Works, of Wilmington, Del.; and the Wrought Iron Bridge Co., of Canton, Ohio, have the contract for the bridge over Wheeling creek and the other smaller spans and trestles on the lines. All of the work is to be completed ready for running trains by Jan. 1, 1890.

TABLE 10-E.

NORTH CENTRAL STATES WATER-WORKS—SOURCES OF SUPPLY.

[Some works have a double source of supply, which increases the total for some States.]

STATE	S'rface	Sp'ngs	Brook	River	Lake	Creek	Wells	Unk'n	T'tal
Ohio	3	10	.....	20	5	3	31	2	74
Indiana	3*	5	.....	17	3	3	11	1	43
Michigan	2	8	.....	16	20	4	34	.....	84
Illinois	2	4	.....	21	8	3	47	5	90
Wisconsin	.....	3	.....	13	8	2	15	1	42
Total N. Central	10	30	3	87	44	15	138	9	333
Per cent	3.0	9.0	.....	26.1	13.2	4.5	41.5	2.7	100.0
" Southern	9.1	23.4	4.7	29.7	4.7	8.6	21.9	3.9	100.0
" Middle	8.3	25.1	10.7	21 6	4.4	14.8	14.1	1.0	100.0
" New Eng.	14.0	17.4	16.3	14.0	†27.1	.....	7.7	3.5	100.0

Some works have duplicate sources of supply, increasing the totals somewhat above the number of works.
*Including one "canal" supply.
†Including 14.7 per cent. of so called "ponds," really lakes.

TABLE 12-E.

FIRE PRESSURE OF NORTH CENTRAL STATES WATER-WORKS, WHEN THE SAME ARE HIGHER THAN THE NORMAL WORKING PRESSURES.

[Nearly all the following are pumping works, but there are a few gravity works which are able to turn on a higher fire pressure from higher reservoirs.]

FIRE PRESSURE lbs. per sq. in.	Ohio.	Ind.	Mich.	Ill.	Wis.	Total.
30-39	.....	.....	.....	.....	.....	.....
40-49	.....	.....	.....	.....	1	1
50-59	.....	1	.....	.....	.....	1
60-69	.....	.....	4	2	1	7
70-79	1	2	2	3	.....	8
80-89	6	6	13	2	2	29
90-99	7	4	9	3	1	24
100-109	7	10	21	9	5	52
110-119	1	.....	2	3	1	7
120-129	5	5	4	8	4	26
130-139	.....	1	2	2	1	6
140-149	1	.....	2	2	2	7
150-159	7	2	1	9	1	20
160-169	1	.....	1	3	.....	5
170-179	.....	1*	.....	4†	.....	5
Total works reporting.	36	32	61	50	19	198

* 200 lbs. † 2 of these, 200 lbs.; 1, 185 lbs.

AMOUNT OF INCREASE ABOVE NORMAL PRESSURE.

10 lbs. or under	.....	.....	1	.....	2	3
10-19	2	1	.....	1	.....	4
20-29	3	4	3	6	.....	16
30-39	2	2	4	4	3	15
40-49	6	4	16	4	7	37
50-59	11	6	12	3	3	35
60-69	4	6	13	9	1	33
70-79	7	6	6	7	1	27
80-89	.....	2	3	3	1	9
90-99	1	.....	.....	2	1	4
100-109	.....	.....	.....	5	.....	5
110-119	.....	.....	.....	2	.....	2
120-129	.....	1	2	2	.....	5
130-139	.....	.....	1	2*	.....	3
Total works reporting.	36	32	61	50	19	198

* 148 and 155 lbs.

TABLE 16-E.

NORTH CENTRAL STATES WATER WORKS—PUMPING MACHINERY.

Makes of Pumps arranged alphabetically	No. of Pumps.						Capacity, millions of gallons.						Totals.		
	Ohio.	Ind.	Mich.	Ill.	Wis.	Total.	Ohio.	Ind.	Mich.	Ill.	Wis.	Total.	So.	Mid.	N. E.
Blake	5	1	7	12	5	30	9.0	2.0	11.5	16.5	12.5	51.5	38.4	26.1	21.4
Cameron	.....	.....	.....	3	.....	3	.....	.....	.....	3.0	.....	3.0	.....	1.6	.....
Corliss	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22.0	20.0
Cornish	8	.....	.....	.....	.....	8	75.0	.....	.....	.....	.....	75.0	.....	19.3	9.0
Davidson	.....	.....	2	.....	.....	2	.....	.....	3.5	.....	.....	3.5	5.0	28.7	12.5
Deane	11	14	11	27	11	74	15.0	23.1	8.5	23.4	15.0	85.0	43.2	19.4	39.5
Galloway	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.0	.....
Gordon & Maxwell	19	5	3	11	3	41	32.5	5.0	3.0	19.8	2.0	62.3	12.6	8.5	.....
Holly-Gaskill	19	27	29	23	10	108	48.5	64.5	60.0	75.8	28.0	276.8	81.0	156.9	17.5
Knowles	11	1	4	5	3	24	45.0	0.1	2.1	10.0	5.2	62.4	18.0	32.1	19.8
Lane	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.2	6.5
Lowry	1	.....	.....	.....	.....	1	2.0	.....	.....	.....	.....	2.0	.....	10.0	.....
Smith & Vaile	5	.....	3	3	4	15	6.8	.....	3.0	0.3	8.0	18.1	4.0	.....	.....
Vilker & Feithsen	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.5	.....
Walker	.....	.....	39	.....	.....	39	.....	.....	31.6	.....	.....	31.6	.....	.....	.....
Wetherill	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0	.....
Wood	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	6.0	9.5
Worthen	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.5	.....
Worth'g'n	26	12	11	31	5	85	57.1	13.3	12.1	54.5	8.0	145.0	87.4	344.6	123.8
Wilson & Snyder	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.0	6.6	.....
Miscell's	21	10	10	24	11	76	51.0	22.5	89.8	148.8	36.0	351.1	70.5	262.2	62.9
Totals	126	70	119	139	52	506	344.9	130.5	225.1	382.1	114.7	1167.3	366.1	981.2	342.1

NOTE. The "Southern" total includes only the South Atlantic and South Central groups; not the Southwestern.

TABLE 11-E.

NORTH CENTRAL STATES WATER-WORKS—AVERAGE WORKING PRESSURES.

[Representing in some of the gravity works the mean pressure in the mains. In pumping works, however, and in most of the gravity works, the pressure is that at the pumps, or principal mains, and hence, considerably higher than the effective pressure.]

Pressure per square inch	Ohio.	India	Michig'n	Illinois.	Wisconsin.	Total
Under 20	1	.....	1	1	.....	3
20-29	1	2	3	1	2	9
30-39	4	4	13	9	3	33
40-49	10	13	34	17	7	81
50-59	9	6	3	9	3	30
60-69	8	4	12	10	4	38
70-79	11	4	4	7	3	29
80-89	4	2	1	6	1	14
90-99	4	.....	2	2	3	11
100-109	3	.....	.....	1	2	6
110-119	2	1	.....	.....	.....	3
120-129	1	.....	.....	.....	.....	1
130-139	.....	.....	.....	.....	.....	.....
140-149	.....	.....	.....	.....	.....	.....
150-159	.....	.....	1	.....	.....	1
Total works reporting	58	36	74	63	28	259

Average Pressure, lbs.	56.5		
" New England	72.5	Average Middle States	68.3
" S. Atlantic	62.0	" S. Atlantic	66.2

TABLE 13-E.

OWNERSHIP OF NORTH CENTRAL STATES WATER WORKS, WITH POPULATION SUPPLIED BY PUBLIC WORKS, ETC.

	Ohio.	Ind.	Mich.	Ill.	Wis.	Total.
City or town	47	25	65	63	11	211
Local company	19	12	14	21	20	86
Outside company	3	5	.....	2	9	19
Individuals	2	1	5	3	.....	11
Unknown	2	.....	.....	.....	.....	2
Total Number	73	43	84	89	40	329
Population supplied by public works	873,304	166,191	335,937	785 936	154,700	2,246,068
P. C. of pop'n supplied by city works	85.4	45.3	77.8	82.2	49.1	74.6
Pop'n on private works	137.011	201.139	96.172	169,556	160,786	764 664
Pop'n per private work	5,270	11,180	5,030	6,500	5,550	6,485
P. C. of census city pop'n supplied by public w'ks.	90.1	50.8	95.1	93.0	56 8	83 6

TABLE 14-E.

NORTH CENTRAL STATES WATER-WORKS REPORTING OVER 100 METERS IN USE.

Cleveland, O.	1,525	Bay City, Mich.	191	Joliet, Ill.	365	Summary
Cincinnati, "	1,320	East Saginaw, Mich.	125	19 others	462	
Columbus, "	480	Grand Rapids, "	401	64 without meters)		
Toledo, "	325	14 others	133			Wks. Meters
	3,610	(67 without meters)		Total, Illinois	4,761	
22 others	569					16 10,630
(48 without meters)		Total, Michigan	843	Milwaukee, Wis.	1,728	
Total, Ohio	4,179	Chicago, Ill.	3,273	13 others	78	80 1,455
		Quincy, "	175	(26 without meters)		233 .....
Indianapolis, Ind.	150	Jacksonville, Ill.	186			
Ft. Wayne, "	133	Bloomington, "	175	Total, Wisconsin	1,806	329 12,085
		Pullman, "	125			
12 others	213					
(29 without meters)						
Total, Indiana	496					

In Middle States	34,956
In New England	37,913
In South Atlantic States	2,889
In South Central States	2,365

TOWNS HAVING OVER ONE-SIXTH OF THEIR TAPS METERED.

	p. c. metered.		p. c. metered.
Brooklyn, O	52.2	Bloomington, Ill	19.4
Grand Rapids, Mich	22.8	Joliet, Ill	91.2
Jacksonville, Ill	53.7	Oak Park, Ill	35.0

TABLE 15-E.

NORTH CENTRAL STATES WATER-WORKS—HYDRANT RENTAL.

(Nearest even $5 taken.)

Hydrant rate.	O.	Ind.	Mich.	Ill.	Wis.	Total No. C.	So th'n	Midd.	N.E.
Free	.....	.....	.....	.....	.....	.....	1	11	14
$5	.....	.....	.....	.....	.....	.....	.....	8	1
10	.....	.....	.....	.....	.....	.....	.....	10	6
15	.....	1	.....	.....	.....	1	1	16	11
20	.....	.....	.....	.....	1	1	.....	10	11
25	1	.....	.....	.....	.....	1	3	13	7
30	.....	1	.....	1	3	5	1	10	17
35	4	2	.....	.....	.....	6	3	9	8
40	1	2	.....	1	3	7	7	17	13
45	4	2	1	2	4	13	2	8	4
50	2	3	4	.....	1	10	14	20	16
55	1	2	.....	1	1	5	2	1	.....
60	2	1	3	2	1	9	5	1	1
75	1	3	4	5	5	18	4	1	1
90	2	1	.....	.....	.....	3	.....	1	.....
100	.....	.....	2	1	1	4	.....	1	.....
Total	18	18	14	13	20	83	47	141	110

The above includes all the works which report a hydrant rental separately. Nearly all the private works receive an indirect rental of some stated sum including water supply of city buildings, etc. Some of the works have a sliding scale decreasing from the above rates for additional hydrants.

The line now under construction begins at the northern line of the city of Martin's Ferry, where connection can be made with the Cleveland, Lorain & Wheeling, Cleveland & Pittsburg, Wheeling & Lake Erie, and Cleveland, Canton & Southern Railways. The line is to be double-track from this northern terminus for about three miles, to the peninsula back of Wheeling, where a connection can be made with a line to the Connellsville coke regions. The single-track line from this point, about three miles long, runs down Wheeling creek and through an 800-ft. tunnel to South Wheeling, where connections can be made with the Baltimore & Ohio, Ohio River, and Pittsburg, Wheeling & Kentucky Railways, and the principal manufacturing establishments in Wheeling.

The entire line will be of first-class construction, stone-ballasted, laid with 72-lb. rails and with al stone or steel culverts, bridges, and trestles. The Ohio River and Wheeling Creek bridges will be double track steel structures. The first will have one 525-ft., three 250-ft., and one 150-ft. through spans, with two trusses placed 30 ft. apart on centres, and with four lines of steel stringers under each track. There will be about 350 ft. of deck approaches on steel trestles, in spans of 30 to 110 ft. on each side of the river spans. The Wheeling Creek bridge will have two 125-ft. deck spans with two trusses placed 27 ft. apart, nine lines of steel stringers under the tracks, and one 50-ft. deck span over the Wheeling & Elm Grove Railway.

The line has two double-track tunnels, about 700 and 1,200 ft. long respectively, between the Ohio river and Wheeling Creek bridges, and a single-track tunnel, about 800 ft. long, in South Wheeling. The whole work, including lands, station houses, and equipment, is estimated to cost about $3,500,000.

JOB ABBOTT, C. E., of 150 Broadway, New York' is Chief Engineer for the company, and H. F. DUNHAM, C. E., of Cleveland, Ohio, is Engineer-in-charge, with office in Roger's Block, Wheeling, W. Va.; GILMAN BROWN, C. E., of Frederickton, New Brunswick, is First Assistant Engineer, and LEE L. DAGRON, of Pittsburg, Pa., is Chief Inspector of Bridges. Work was actively commenced on the line in October last, and has been pushed steadily through the winter. The east abutment and several pedestals for the east approach of the Ohio River bridge have been completed, and stone is being quarried and delivered for all of the masonry. The face cuts have been made for the 700 and 1,200 ft. tunnels, and headings are being driven at both the north and south ends. A temporary bridge has been completed over Wheeling creek, the heavy cutting made in the peninsula, and grading is in active progress along the line on Wheeling creek. The principal street crossings are made above or below grade, and there will be only one grade railway crossing.

The Convention of the State Railway Commissions with the Interstate Commerce Commission.

In accordance with the invitation of the Interstate Commerce Commission, Representatives of the several State Railway Commissions and of the Association of American Railway Accounting Officers met at Washington, D. C., March 5. The following gentlemen were present:

Interstate Commerce Commission: THOMAS M. COOLEY, Chairman; WILLIAM R. MORRISON, AUGUSTUS SCHOONMAKER, ALDACE F. WALKER, WALTER L. BRAGG, Commissioners; EDWARD A. MOSELEY, Secretary; HENRY C. ADAMS, Statistician.

State Railroad Commissioners and Accredited Representatives: Alabama, HENRY R. SHORTER; Connecticut, GEORGE M. WOODRUFF, WILLIAM O. SEYMOUR; Florida, WILLIAM HIMES; Georgia, A. C. BRISCOE, Secretary; Iowa, SPENCER SMITH, FRANK T. CAMPBELL; Kentucky, I. A. SPAULDING, A. R. FLEMING, J. F. HOGAR; Maine, DAVID N. MORTLAND, ROSCOE L. BOWERS, Commissioners; Massachusetts, GEORGE G. CROCKER, EDWARD W. KINSLEY, EVERETT A. STEVENS; Michigan, JOHN T. RICH, Minnesota, TAMS BIXLEY; Missouri, WILLIAM G. DOWNING; Nebraska, G. L. LAWS, T. H. BRENTON, WILLIAM LEESE, I. E. HILL, JOHN STEEM, J. H. AGER, Secretary, O. P. MASON, Secretary, H. M. WARING, Chief Clerk; New Hampshire, JOHN W. MITCHELL, B. F. PRESCOTT, Clerk; New York, MICHAEL RICKARD; Ohio, WILLIAM S. CAPPELLER; Pennsylvania, ISAAC B. BROWN; South Carolina, MILLEDGE L. BONHAM, D'ARCY P. DUNCAN, EUGENE P. JERVEY; Vermont, SAMUEL E. PINGREE, TRUMAN C. FLETCHER, EBENEZER J. ORMSBEE; Virginia, JAMES C. HILL; Wisconsin, ATLEY PATERSON. Also Gov. LARRABEE, of Iowa; L. S. COFFIN, of Iowa; L. G. BANNISTER, of Iowa; Dr. HEARDSLEY, of Iowa, and E. F. HOBART, of New Mexico.

The following members of the Association of American Railway Accounting Officers were also present:

M. M. Kirkman, President, comptroller of Chic. & N. W. R. R.; M. Riebanock, Vice-President, assistant comptroller of Pa. R. R.; Stephen Little, chairman of Executive Committee, auditor of Pullman P. C. Co.; C. G. Phillips, Secretary.

Of the Executive Committee: D. A. Waterman, auditor of Mich. Cen. R. R.; J. P. Whitehead, comptroller of Atch., Top. & Santa Fé R. R.; C. Kelsey, auditor of the Chic & Alton; Cushman Quarrier, comptroller Louis. & Nash, R. R., and S. M. Williams, comptroller Central R. R., N. J.

A full report of the proceedings of the Convention will be given in our next issue.

THE VESTIBULE PATENTS are having a final hearing before Judges GRESHAM and BLODGETT in Chicago. This is the case of the Pullman Palace-Car Co., against the Wagner Palace Car Co., for infringement of patent. This suit was decided by the same judges last May, when they granted an injunction against the Wagner Co., enjoining it from using the patents used in the vestibuling of trains registered by HENRY HOWARD SESSIONS on Nov. 15, 1887. The injunction was afterward modified so as to permit the Wagner people to continue the operation of vestibuled trains upon filing bonds to indemnify the complainant for any infringement, and a rehearing was also secured. Since then the Wagner Co. claims it has secured evidence which will convince the court that the Sessions patents are invalid on account of lack of novelty. The complainant does not claim any value for the vestibule designs, but holds that it is entitled to protection for the Sessions patent for buffer plates, which tend to reduce the oscillation of trains to a minimum, rendering travel on such trains not only endurable but positively a luxury.

CORK CAR SPRINGS are being experimented upon in France. A set of twelve disks are connected together by a central stem, each disk about 7 ins. in diameter and 6-10 ins. thick. On the Northern Railway such sets of disks were subjected to a pressure of 15,600 lbs. per sq. in., and were compressed to one-fifth of their original thickness: on removing the pressure the cork regained its original bulk in ten minutes.

PERSONAL.

Mr. A. M. WELLINGTON has been elected a Member of the Institution of Civil Engineers.

Mr. HENRY HASBROUCK, Water Commissioner of Poughkeepsie, N. Y., has resigned.

Mr. EATON has been elected City Engineer of Los Angeles, Cal.

Mr. J. A. HANLEY, Traffic Manager of the Chicago, St. Paul & Kansas City, has resigned, and the position has been abolished.

Mr. C. W. MCCRACKEN, Resident Engineer of the Louisville, St. Louis & Texas, at Owensboro, has moved his headquarters to Louisville, Ky.

MR. WILLIAM JACKSON, City Engineer of Boston, Mass., has been reappointed to that position for the year beginning in April.

Mr. PHILIP J. DOHERTY has been appointed a Water Commissioner at Boston, Mass., vice Mr. SMART whose term has expired.

Mr. CHARLES A. GODDARD has been reappointed to the position of Superintendent of the lower division of the Ohio canal.

Mr. W. B. DUNN, formerly President of the Mobile & Great Northern Railroad Co., now a part of the Louisville & Nashville, died recently at Mobile, Ala., aged 81 years.

Mr. J. M. ZIEGLER has been appointed Superintendent and Passenger and Freight Agent of the Adirondack Railway, with headquarters at Saratoga Springs, N. Y.

Mr. J. T. HARAHAN, Assistant General Manager of the Lake Shore & Michigan Southern, has resigned to accept the position of General Manager of the Chesapeake & Ohio, vice Mr. ODELL resigned.

Col. GEORGE W. FRIEDLEY, General Solicitor of he Louisville, New Albany & Chicago Railway, died at t Bloomington, Ind., Feb. 28. He was one of the best known railway lawyers in the West. His home was in Lafayette, Ind.

Mr. WM. J. MCALPINE has been suffering severely from an inflamed eye for the past two months, having been confined for most of the time to a dark room; but engineers everywhere will be gratified to learn he is now much better.

Mr. F. J. KROM has been appointed Assistant General Car Agent of the Lehigh Valley, with office at Sayre, Pa. In addition to his present duties, he will have entire charge of the distribution of cars on the Northern Division.

Gen. DAVID P. DEWITT died recently at Middletown, N. Y., at the age of 72. He was born in Hoboken, N. J., July, 10, 1817. He entered West Point Military Academy in June, 1832, was graduated and commissioned as Second Lieutenant, Second Artillery, United States Army, in 1836. He resigned and entered the employ of the New York, Lake Erie & Western Railroad. After a long service with this company he was engaged in civil engineering in Canada, and afterward in railroad contract work in Ohio, Pennsylvania, and Kentucky. In 1859 he entered the service of the United States Express Company, but resigned to enter the United States army in 1861.

CORRESPONDENCE.

Comparison of Formulæ for the Strength of Columns.

ROCHESTER, N. Y., Feb. 16, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

My attention was called to-day for the first time to an article upon the above subject by Mr. THOS. H. JOHNSON, in your issue of Dec. 22, '88. In this article Mr. JOHNSON claims that in an article of mine published in ENGINEERING NEWS, Oct. 6, '88, I convey "the impression that the use of the straight-line formulæ" was first suggested by me, and that "such formulæ are of necessity only approximations, and not correct exponents of the law governing the behavior of long columns."

I believe with Mr. JOHNSON that these impressions are erroneous, and therefore do not understand how he can have received such impressions from my article. Almost two years ago (May 21, '87, page 330) I said in your valuable paper:

> In a discussion on a paper read, June 23, 1885, before the American Society of Civil Engineers, by Mr. JOSEPH M. WILSON, on "Specification for Strength of Iron Bridges," Mr. EDWIN THACHER pointed out the fact, with reference to the strength of wrought-iron struts, that a straight line could be made to represent graphically "more nearly than any of the proposed curved lines," the average temporary strength of wrought-iron flat-ended struts.

The only claim I made in my article in your issue of Oct. 6, '88, was that I was the first to use the straight-line *tangent to* RANKINE'S *curve at the point of inflexion.*

How the second impression can have been conveyed I do not understand, for it was not within the province of my article to say whether the straight-line formula was or was not a correct exponent of the law governing the behavior of long columns. All I endeavored to do in that article was to show those engineers who had faith in no other formulæ than RANKINE'S that there were straight-line formulæ which would give, with less labor, results as close to the results derived from the formulæ of RANKINE given, as any practical engineer ever wishes to obtain.

A. D. OTTEWELL.

Maintenance of Country Roads.

MT. VERNON, Ia., March, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

The following suggestions as to country roads are based partly on observation and partly on other sources. If they contain anything worthy of notice, pass them on.

The State laws should be so amended that each county could organize a Board of Public Works, composed the present Board of Supervisors and a competent engineer. The duties of the Board of Supervisors would be the same as now, with a few exceptions. The duties of the engineer would include all those at present incumbent on the County Surveyor, also the planning and supervision of the construction of all new roads, bridges, and other public works, and the supervision of all road work. Road taxes could be collected the same as other taxes, and apportioned to the townships, as is school money. The work should be done by contract, the same as on other public works. The engineer would make all estimates, and report to the Board of Supervisors. Well equipped parties of sufficient number and strength to do the required work could be employed, and on the principle of the division of labor, good machinery, proper supervision, and scientific construction, many times the amount of good realized under the present system would be reaped from an equal amount of expense.

The engineer should be chosen on civil-service principles, by appointment, or in some like way, to the end that he may be removed as far as possible from political influence.

The hap-hazard and careless way in which road work is done and the scandalous abuse of political influence in securing contracts for public works are evils that have been far too long tolerated. A READER.

The Sayre, Pa., Syphon Problem.

POCATELLO, Idaho, Feb. 27, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In ENGINEERING NEWS of Feb. 16, "W. A. S." wants to know how the syphon at Sayre, Pa., can be made a success. I think that I can help him so that he can drain the pond; I would proceed as follows:

Place the inlet end 4 ft. below the lowest water line, take the trap off of the discharge, and arrange it to discharge, under water, so as to utilize all of the head; connect a 1¼ in. pipe from the hydrant to the syphon (it would be easier to make this connection at one of the 90° bends), reduce the size of the pipe to 1 in., close up to the syphon, and extend it into the syphon in such a manner as to stop the flow as little as possible, putting the nozzle in the center of the syphon pipe, and pointing toward the discharge end, thus making an injector.

If an inch nozzle gives too much water, it can be reduced to ¾ in. To prime, close both ends of the syphon, open the air cock on top of the air chamber, open valve between bottom of air chamber and the apex of the syphon. Then fill pipe and air chamber with the present pipe from the hydrant to the air chamber, the air escaping through the air cock in the top of the chamber. To start it running, close pipe from chamber to hydrant, close air cock, open both ends of syphon, and it will start running. Open injector pipe, and it will flow a good strong stream. As the water recedes from the air chamber you can tell its height by tapping on the chamber with a hammer. When necessary to re-fill the chamber, close the valve connecting the bottom with the pipe, and open the air cock; then the chamber can be filled from the hydrant. Let the injector and the syphon run right along while the re-filling of the chamber is being done. Do not try to keep the chamber full all the time, and never allow it to be filled unless the connection with the syphon is closed.

If the syphon fails after applying the injector in a proper manner, it is due to the porosity of the pipe and joints. To remedy this evil, cover the joints with white and red lead made into a putty by Japan varnish and boiled linseed oil, and cover the pipes and air chamber with a coating of coal-pitch varnish. I will await the results of this treatment, which I trust will be communicated to you, with much interest.

G. H. N.

The Bicycle Principle for Railways.

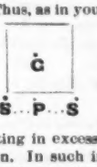
Potter Building, 143 Nassau St.,
NEW YORK, March 4, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I read yesterday with much interest the editorial discussion of "The Bicycle Principle for Railways" in your last week's ENGINEERING NEWS.

Would not the application be more practicable, besides being more convenient and cheaper, if between the two rails a third track were laid centrally upon which would rest the "bicycle" wheels of the train, these being slightly larger in diameter than the outside "guide" wheels?

Thus, as in your "triangular diagram," the added point



P indicates the central support of the train when in motion. The other guide-wheels *S* or *S*¹ impinge upon one or the other of the outer tracks, as the case may be, only when the train is stopped; or when in motion to prevent tilting in excess of the prearranged limit for lost motion. In such instance it is, of course, evident that the outside or guide rails might be of much lighter construction than the central bearing rail *P*. It seems to me that this modification exactly meets the exceedingly clever illustration used in the editorial, of two hoops, one being formed from a band and the other from a wire.

Yours truly,
JOHN THOMSON.

[This idea occurred to us, and probably to others. Such lateral support, as compared with an overhead guide-rail, has the advantage of simpler construction, but the disadvantage of greatly decreasing the effectiveness of the guide-rail support because of the shorter leverage. Consequently, much greater resisting power and perfection of alignment would be necessary than for the overhead rail.—ED. ENG. NEWS.]

Pile-Driving Formulæ.

CHICAGO, Ill., Feb. 28, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

In your issue of Jan. 19, 1889, a desire is expressed for a more accurate formula for the resistance of piles than $P = \frac{w h}{s}$ and which would also be simple enough for the average inspector.

The inaccuracy of the formula $P = \frac{w h}{s}$ is not due to taking into account the velocity of the blow, but simply because the work of compressing the pile is disregarded.

RANKINE ("Civil Engineering," p. 604) gives the following equation for work done by blow of the ram:

$w h = P s + \frac{P^2 l}{4 E S}$, in which P = resistance of pile, l = length of pile in feet, S = average area in square inches, E = modulus elasticity = 1,500,000.

The following table gives the value of $\frac{P^2 l}{4 E S}$ for varying values of P, and for three proportionate sizes of piles, within the limits of which nearly all the piles of ordinary practice will come.

P	$\frac{l}{s} = \frac{2}{1}$	$\frac{l}{s} = \frac{1}{1}$	$\frac{l}{s} = \frac{1}{10}$
50,000	167	83	40
75,000	375	187	93
100,000	667	333	167
125,000	1,040	520	260
150,000	1,500	750	375
175,000	2,040	1,020	510
200,000	2,667	1,333	667
225,000	3,370	1,685	843
250,000	4,160	2,083	1,040
275,000	5,040	2,520	1,260
300,000	6,000	3,000	1,500
325,000	7,040	3,520	1,760
350,000	8,160	4,080	2,040

From this table take the proper value of $\frac{P^2 l}{4 E S}$ and substitute in equation

$$P = \frac{w h - \left(\frac{P^2 l}{4 E S}\right)}{s}$$

If it is desired to drive piles until they give a certain resistance, say 200,000 lbs., it is only necessary to memorize one quantity. These quantities are so small in comparison with $w h$ that close approximation is not necessary. They should be increased when the top of the pile becomes "broomed," or if it be very slender or lacking in elasticity. With an inspector of intelligence and good judgment, great accuracy can be attained, while in any case the results will be much more accurate than with the "practical" formula, $P = \frac{2 w h}{s + 1}$.

C. D. HILL, C. E.

[Assume in the "practical" formula, $P = \frac{2 w h}{s + 1}$, w (hammer) = 3,000 lbs., h (last fall in ft.) = 30 ft., s (last penetration) = 1 in. Then we have $P = \frac{2 \times 3{,}000 \times 30}{2} = 90{,}000$ lbs. safe value for P.

Attempting to get a corresponding value for P from our correspondent's formula, and first to find the resistance of pile, P, at about 90,000 lbs., or say 100,000 lbs., we have

$$P = \frac{90{,}000 - (167 \text{ to } 667)}{1}$$

or practically an identical result.

Letting $s = 3$, we have by the "practical" formula, $P = 45{,}000$ lbs., and by our correspondent's:

$$P = \frac{90{,}000 - (40 \text{ to } 167)}{3} = 30{,}000 \text{ lbs. nearly.}$$

This seems the safer value; but let us assume the very common case of $s = 0+$, and we have for P by the "practical" formula, $P = 180{,}000$ lbs.; by our correspondent's, P = infinity. Any formula which gives an infinite value for no penetration is in our judgment useless, and the difference between the resulting values from using one or the other of the three columns is too trifling to be worth consideration in so essentially uncertain a problem. Neglect the term $\left(\frac{P^2 l}{4 E S}\right)$ and the formula reduces to — what in any case it practically is:

$$P = \frac{w h}{s}, \text{ instead of } P = \frac{2 w h}{s + 1}$$

Which of these is the safer and more rational formula? They are identical for $s = 1$ in., which may be called the unit value for last penetration of piles. Taking it as such, and comparing the relative resistance which the two formulæ give for other penetrations, we have:

	By $P = \frac{w h}{s}$	By $P = \frac{2 w h}{s + 1}$
$s = 1$ in., $P =$ say	1.00	1.00
$s = \frac{1}{2}$ in., $P =$	2.00	1.33
$s = \frac{1}{4}$ in., $P =$	4.00	1.60
$s =$ zero $P =$	infinite	2.00

On the other hand, for larger penetrations, we have:

$s = 2$ ins.	0.50	0.67
$s = 4$ ins.	0.25	0.40
$s = 8$ ins.	0.125	0.222

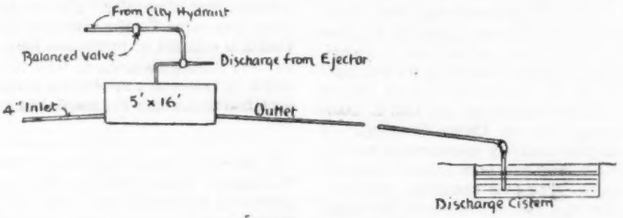
Which of these columns shows the more rational values? It appears to us clear that the last does throughout, for reasons given in full in our issue of Dec. 29, 1888, apart from the fact that it in no case reduces to an absurdity.—ED. ENG. NEWS.]

A Syphon Problem.

CHICAGO, Ill., Feb. 21, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

Referring to "A Syphon Problem" in the correspondence of Vol. xxi. No. 7. If the parties having the matter of drainage in hand will put a large tank, say 5 x 16 ft., in the line of pipe at the highest level, making the outlet and inlet connections in the heads near the bottom, and then take off an air-pipe from the top of the shell, lead it to an air-pump, all being set up to stop and start automatically; and if they will further make the discharge end of the line terminate in an open cistern or pool, holding water enough to keep the air-pump from drawing air, they will be able to keep up a continuous flow of water.



A Syphon Problem.

I have used this appliance with success on shorter lines of piping, taking an ejector for an air-pump, connecting the steam inlet to the city hydrant for power. The suction inlet is connected to the 5 x 16 ft. air chamber spoken of above, and the flow of water from the city hydrant is automatically started and stopped by means of a ball float and lever operating a balanced valve in the pipe from the hydrant to the ejector, or vacuum pump. But it would seem that a 4-in. pipe was rather small for "great expectations" on so long a run.

Very truly yours,
I. LINCOLN, Jr.

The Lorini Diagram.

CAMBRIDGE, Mass, Feb. 27, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

The meritorious device of M. LORINI, of Yonkers, N. Y., for plotting contours, I have seen in use in the office of EDW. P. ADAMS, of Boston, and I think was, so far as he is concerned, devised by him.

The following method which I have found to work well in practice, I have never seen described, though from its simplicity, I doubt not it has suggested itself to others.

The vertical lines on a sheet of cross-section paper are numbered from left to right to represent horizontal distances, and the horizontal lines are numbered to represent elevations. Prepare a number of needle-points. One person with the note-book calls off the horizontal distances and the corresponding elevations, another, with the sheet of cross-section paper before him, sticks in the needle-points at the distances and heights as given. Then, laying a thread along the needle-points, he reads off the horizontal distances at which the thread crosses the desired contour heights. The first person, with his scale laid along the line on the map, pricks off the distances as they are called off. The contour heights on the cross-section paper should be ruled in black, or in some way be made readily distinguishable to catch the eye. Several sheets of paper may be pasted together, or a long sheet of profile paper used, and a long line may, with a little practice, be "stuck" on the cross-section paper, and the points at which the desired contours cross the line pricked off on the map, almost as rapidly as the data can be called off.

J. H. STUBBS.

PUBLICATIONS RECEIVED.

—Report on a General Plan for a System of Sewerage for the City of Reading, Pa. With a discussion of the sanitary needs of the city, and sewage disposal. By CARROL PHILLIPS BASSETT, M. Am. Soc. C. E.

This report covers sewerage plans for a city having an area of about 3,850 acres and a population of nearly 60,000, with an average slope upward from the Schuylkill river of about 20 ft. in 1,000 ft. The report is carefully worked out and accompanied with estimates of cost of the works. Sewage disposal by the river and by filtration and chemicals is discussed.

—Special Report of the Commissioners of Sewerage and Water Supply of St. John and the Town of Portland, N. B., on the Formation of Anchor Ice. By GILBERT MURDOCK, C. E., Superintendent.

This is a full and valuable report on a subject of much interest to managers of water-works. It contains a detail of the trouble in St. John, the method adopted for restoring circulation of water, and the means suggested for prevention. The document also includes much interesting experience in other cities from the formation of anchor ice. It is not a very late report, but is none the less valuable.

—Thirty-Sixth Annual Report of the Railroad Commissioners of the State of Connecticut. GEORGE M. WOODRUFF, WM. H. HAYWARD, WM. O. SEYMOUR, Commissioners. 6x9 ins, 510 pp., cloth bound. With map and excellent tables. Published by the State.

The Commissioners are entitled to much credit for the promptness with which their report appears. It is the first report for the year 1888 which has yet reached us We hope to review it at length in an early issue.

—Report on the Natural Advantages and Water-Power Facilities of the City of Manchester, Chesterfield Co., Va, Col. C. P. E. BURGWYN, C. E. Pamph. 3 maps and profiles.

The following interesting comparison is included in this report, which explains itself by title, and closes with a useful table of docks.

The 2,000 ft. of water falling 116 ft. will give 26,285 H. P. The horse power of the James at Manchester is usually stated at 21,040. The following table gives a comparison of the horse power of the various cities for the summer season, as usually stated:

City.	*Horse Power.*
Manchester, Va	21,040
Holyoke, Mass	12,200
Manchester, N. H	12,000
Lowell, Mass	11,845
Lewiston, Me	11,000
Lawrence, Mass	10,902
Cohoes, N. Y	6,556

Thus it will be seen that during the great freshet the horse power of the James at Richmond was over 2,000,000, and the ordinary summer conditions compare most favorably with other cities.

The total theoretical horse power of the James, the Appomattox, and the interior creeks, sums up nearly 40,000. At $28 a year, this power represents a value of $1,120,000 annually.

—Catalogue of Paints and Colors for Railway Use, manufactured by the Sherwin-Williams Co., Cleveland, Chicago, and New York.

This elegant volume, for such it is, is chiefly devoted to samples of the various paints manufactured, which are in surprising variety. They are also neatly shown by colored plates applied to cars, bridges, water tanks, etc. The volume closes with a concise account of the origin of each prominent pigment, with some excellent samples of lettering, and with a single plate of designs for car ornamentation, a feature which might judiciously be extended. As a whole the volume is a credit to the publishers, and likely to be valued by recipients. It only lacks for completeness a title on the back.

—Recent Papers of the Institution of Civil Engineers. "Witham New Outfall Channel and Improvement Works," by J. E. WILLIAMS. "Failure of the Kali Nadi Aqueduct on the lower Ganges Canal," by W. H. THELWALL. "Manufacture of Oil Gas by the Pintsch System, and Lighting of Railway Carriages," by G. M. HUNTER. "Influence of Chemical Composition on the Strength of Bessemer Steel Tires," by J. O. ARNOLD. "Friction Brake Dynamometers," by W. W. BEAUMONT. "Surveying: Preliminary Surveys in New Countries," by T. G. GRIBBLE; "Rapid Surveying," by F. D. TOPHAM; "Surveying in Australia," by S. K. VICKERY.

—Chester, Pa.: A History of its Industrial Progress and Advantages for Large Manufactures. An illustrated pamphlet of 65 pp., compiled and published by direction of the Board of Trade.

—Proposed Improvement of the Bar at the Entrance to the Rio Grande do Sul, Brazil. By LEWIS M. HAUPT. Paper before Engineers' Club of Philadelphia, read Nov. 3, 1888.

—The Interior of Fort Garry, Winnipeg, Manitoba. This is an artistic and interesting lithograph in colors of the interior of this old trading post as it appeared before Winnipeg was. It is done from a water-color sketch by Mr. H. A. STRONG of Winnipeg, and is published by the artist as "a vanishing scene in the early history of our country."

—The Aneroid Barometer, its Various Forms, its Theory, and its Use, with Special Reference to the Determinations of Altitudes. By E. A. GIESELER, C. E. Brandis Manual Co., publishers. 25 cts.

This is a concise, well digested, and handy little pamphlet of 11 pages on the theory and use of this valuable instrument.

SOCIETY PROCEEDINGS.

Western Society of Engineers.—At the meeting of this Chicago society on Feb. 6, the Committee on Highway Bridges presented the following report:

"The committee appointed to report on the best means of improving highway bridge construction begs to report as follows:

The committee has held several meetings and been in correspondence with committees appointed by kindred societies. A draft of an act of Legislature to promote the safety of bridges, prepared by the committee of the Engineers' Club, of Kansas City, together with a memorial to the legislature of Missouri, has been received and is submitted herewith.

Your committee has carefully considered this draft of an act, and while it is of the opinion that changes in details are desirable, and in part necessary, it recommends this draft as in principle, the best method yet proposed of remedying the existing evils.

The proposed act is not confined in its application to highway bridges only, but deals with railway bridges as well. There appears to be justification for this. While bridges are well cared for on most railways, they are not properly cared for on some, and an accident is much more serious in their case than in the case of highway bridges. It was thought, too, that an act dealing only with highway bridges was sure, sooner or later, to be amended by the Legislature so as to include railway bridges also, in which case the amended act would probably not be as satisfactory as an act planned to apply to both types of bridges from the start.

The act does not include the appointing of a state engineer. Such an officer will undoubtedly be needed if the act should become a law, but it was thought advisable by the framers to ask for no legislation which would entail extra expense upon the State.

After mature consideration, your committee has concluded that it would be inopportune at this time to attempt to obtain legislation in this State, as the prospects of success are very small. Public attention has not yet been sufficiently aroused to the need of legislation of this character, and an effort on the part of engineers only will be looked upon as an attempt to furnish employment to the members of the profession, and not as a disinterested movement to secure a public good.

At some future time the necessity for legislation will undoubtedly become apparent to the general public, and the present preparatory work will not be wasted.

Your committee begs to report without recommendation and requests to be discharged."

C. L. STROBEL,
A. GOTTLIEB,
E. C. CARTER,
Committee.

Mr. LILJENCRANTZ was appointed to take charge of the new "employment" department, for the assistance of engineers in search of work.

JOHN W. WESTON, *Secretary.*

Rensselaer Society of Engineers.—A special meeting was held at Troy, N. Y., March 1. Mr. W. B. HAMMOND, of Boston, described "Gold Mining in the Black Hills of Dakota." He spoke of the geological formation of the gold-bearing district and then of various processes and expedients used in mining.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Baltimore & Eastern Shore.—This Maryland company proposes to build a railway from Easton to Salisbury, 54 miles. Control has been secured of the Wicomico & Pocomoke Railroad, extending from Salisbury to Ocean City, 30 miles; and the road would thus furnish a direct route, 84 miles in length, across the eastern peninsula of Maryland. Citizens of the counties which the road would traverse have taken stock to the amount of $150,000, and the counties have voted to endorse the company's second mortgage bonds to the amount of $105,000. The company has secured subscriptions to its bonds to the amount of $250,000, outside of Baltimore, and now asks that city to take $75,000 of these bonds. If this is secured, it is promised that work will be commenced at once.

Philadelphia & Reading.—Surveys are completed for the extension of the Camden, Gloucester & Mt. Ephraim R. R. from Mt. Ephraim to Spring Mill, N. J., about 7¼ miles. The cost is estimated at $100,000

Raritan River.—Trains are now running from South River to South Amboy on this New Jersey road. Grading is to be pushed at once on the extension from South Amboy to Bound Brook, 21 miles. E. W. HARRISON is Chief Engineer.

New York, New Haven & Hartford.—Several surveys have been made for the extension from Farmington to New Britain, Conn. Work on the grading will probably begin in early spring.

Lehigh Valley.—The proposed Buffalo & Geneva extension to Buffalo, N. Y., is noted on our Engineering News page. The *Coal Trade Journal* says that the recently incorporated Beech Creek & Hudson River road in Pennsylvania will be used by the Lehigh Valley. It is to extend from Watsontown, on the Susquehanna river, west, toward the Clearfield coal fields, and will terminate for the present at Newberry, Lycoming County. The new line will be about 26 miles in length.

Housatonic.—The fight over the proposed parallel to the New York, New Haven & Hartford, which this company wishes to build, is still in progress before a committee of the Connecticut Legislature; there are no reliable indications as yet, concerning the chances of either side's victory.

Pittsburg & Lake Erie.—At the recent stockholders' meeting, it was voted to increase the capital stock $4,000,000, for the purpose of extending the double tracking and straightening the line.

Columbus, Lima & Milwaukee.—Chief Engineer R. P. VAN DUZEN is making the final surveys between Lima and Defiance, O.

Vincennes & New Albany.—It is announced that grading will begin on this Indiana road as soon as spring opens. The right of way has been all secured.

Cleveland & Canton.—Tracklaying is in progress on the extension from Coshocton to Zanesville, O., and the graders are at work on the Chagrin Falls branch.

New York & Ohio.—It is stated that Pierce and Norton, two sub-contractors on this Ohio road, have made an assignment. Their failure will not affect the construction of the road.

Central Massachusetts.—It is stated that the branch to the Connecticut river at some point south of the present terminus, which was proposed two years ago, is now under survey from Bondville to Springfield.

Spencer.—This short Massachusetts road, 2.17 miles in length, which has been operated by the Boston & Albany, will be run independently after April 1. A new locomotive and freight and passenger cars will be bought. LUTHER HILL, of Spencer, is President.

Pittsburg, Chartiers & Youghiogheny.—It is again reported that ANDREW CARNEGIE and others contemplate an extension of this road to secure an independent outlet to Lake Erie, and that surveys are already in progress.

Pennsylvania.—It is stated that an extension of the West Jersey system is to be built from Medford to Mannahawken, N. J.; and that right of way has been secured and the line will be put under contract at once. The new line will be about 35 miles in length and will give Philadelphia a road to Long Branch but little longer than the present road to Atlantic City. It is reported that the Reading intends to build over a parallel route to the above. Another project which the Pennsylvania managers intend to carry out is a sea-coast line from Sandy Hook to Cape May. By the building of a few connecting links, trains could be run for almost the whole distance of 130 miles within sight and sound of the ocean.

Central Railroad of New Jersey.—A trackage right has been secured over the Belvidere division of the Pennsylvania system to enable this road to connect with the Lehigh & Hudson Railroad. There will be no need, therefore, of building the extension for which surveys were made from Phillipsburg to Belvidere, a few months ago.

Baltimore Belt.—WM. GILMOR, President of the Maryland Central R. R., is pushing this enterprise, and hopes to begin construction at an early date.

Canadian Pacific.—This company is seeking permission from the Dominion Parliament to refund its debt by an issue of $85,000,000 in bonds bearing interest at not more than 4 per cent.

Central Michigan.—We have received the following information from J. W. BOYNTON, of Grand Rapids, Mich., President:

This road is to run from Rogers City, on Lake Huron, south via Grayling, Harrison, Freeport, Battle Creek and Coldwater, a distance of 350 miles. Twenty miles of this distance, purchased from the Lowell & Hastings R. R. Co., is completed and in operation, and surveys for the remainder are nearly completed. The route is favorable, affording easy grades and curves and passing through the heart of the rich pine and hard-wood timber lands of Northern Michigan. The principal business will be in the transportation of lumber, iron and coal ore and farm products. Nearly all of the right of way has been secured and local aid amounting to $250,000 has been pledged. Tracklaying will begin at once and it is expected to lay 60 miles this year. J. H. ROBERTS, of Grand Rapids, Mich., is Chief Engineer.

Evansville, Fort Wayne & Chicago.—The Keene Bros., Construction Co., 611 North Main St., St. Louis, Mo., inform us that the report published last week of their contract on this Indiana road is correct. The contract price for 109 miles is $336,840.11.

Projects and Surveys.

Georgetown & Milton.—A bill has been introduced in the Delaware Legislature by SENATOR DORMAN, Ex-Governor STOCKLEY, J. R. POYNTER and others to incorporate the Georgetown & Milton R. R. Co. The road is projected to run from Georgetown via Milton to Draw Bridge.

Milford & Lake Michigan.—Incorporated in Indiana

to build a line of railway from Milford Junction, Kosciusko county, to South Bend, a distance of 40 miles. The capital stock is $320,000.

Cincinnati Circular.—Incorporated in Ohio by CHARLES SCHIFF, RALPH PETERS, H. H. TATEM, SAMUEL HUNT and others to build a railway from a point near Sedansville, on the Cincinnati, Indianapolis, St. Louis, & Chicago, around the city of Cincinnati to a point near Red Hand on the Little Miami R. R. The road is to be built by an independent company to do business as a belt line transfer for all roads entering the city.

Penn's Mountain.—This proposed road at Reading, Pa., is to run from a point near the Walnut Street entrance to Penn's Commons, by an inclined plane to the highest point of the mountain, about 600 ft. above the Schuylkill river; from there it will run around the mountain and return to a point in front of the city of Reading above Penn's Commons, a total distance of about 5 miles. Nearly all of the right of way has been obtained, and as soon as the rest is secured the company will begin construction. The inclined plane will be operated by a 100-H. P. engine placed at the summit, and from here the trains will run by gravity to the terminus. The cost of the road is estimated at $100,000. THOMAS P. MERRITT and others of Reading are interested.

State Line & Oakland.—The locating surveys are in progress on this road, which is to run from a point on the Baltimore & Ohio R. R. near Confluence, Pa., crossing the Youghiogheny river near Sloan's Ford and continuing along the west bank through Somerfield, Pa., Selbys port and Friendsville to Oakland, Md., a distance of about 45 miles. The road is projected by Philadelphia and Baltimore capitalists who own valuable tracts of timber land along the route. It is stated that work on construction will begin soon, and the road will be completed by Aug. 1, 1889. J. U. CRAWFORD, Fox Chase-Philadelphia, is Chief Engineer.

Vincennes, Oakland City & Owensboro.—We have received from Vice-President EDWARD WATSON of Vincennes, Ind., the prospectus of this enterprise. The company was organized in September, 1887, and surveys were made by Chief Engineer W. B. ELLS from Vincennes, Ind., to Owensboro, Ky., a distance of 70 miles The route as surveyed gives a maximum grade of 52 ft. per mile, and a maximum cut of 31 ft. There will be two large bridges, one across White river dividing Knox and Pike counties, and the other across the Ohio near Owensboro. The company has secured subsidies, which, including 50¾ miles right of way, amount to $112,000 from the towns along the route. The annual earnings of the road are estimated at about $600,000, and expenditures for fixed charges at $150,000. The Owensboro & Indiana Bridge Co. has been organized in connection with the road to build the bridge across the Ohio. The site is 1¾ miles west of Owensboro, where the distance to be spanned is 1,900 ft., and an underlying bed of rock affords a solid foundation for piers and abutments. The cost is estimated at less than $1,000,000. JAS. C. RUDD, of Owensboro, is President of the railway company and J. D. POWERS, of Owensboro, is President of the bridge company.

Emporium & Williamsport.—It is reported that surveys are being made for a railway from Emporium, Pa., to Williamsport, Pa., making a connection between the Western New York & Pennsylvania R. R. and the Philadelphia & Reading R. R. The length of the road will be about 65 miles.

SOUTHERN—Existing Roads.

Craig Mineral.—W. G. SEARS, Chief Engineer of this road, with office at Eagle Rock, Va., gives us the following information.

This road is now under contract from Eagle Rock to New Castle, Va., a distance of 25 miles. The Sears Construction Co. has the contract, and is now making surveys. Extensions are projected from New Castle to Roanoke, 28 miles, and from New Castle to New River, 35 miles. There will be a 2-span bridge about 300 ft. in length across the James river, and a single span bridge across Craig's creek 150 ft. in length. Contracts for these will be let about April 1.

Middleburg, Highland & Lake Butler.—The Chattanooga *Tradesman* has the following regarding this Florida enterprise:

WM. VARNEDOE, Superintendent of the Middleburg, Highland & Lake Butler Railroad, says that the road has not yet been completed, but that the work is being vigorously pushed, and by April 1, he thinks it will be finished. The road runs from Middleburg, a prosperous little town in Clay county, to Highland, where it crosses the line of the Florida Railway and Navigation Company. It passes then over to Lake Butler, penetrating a country in which no other railroad runs.

Tennessee Midland.—Track is laid and trains are now running to Darden, Tenn., 40 miles east of Jackson and 125 miles of east of Memphis. The road will be finished to the Tennessee river, 10 miles farther, in 30 days.

Roanoke & Southern.—The Board of Directors have authorized Vice-President J. W. FRIES to act as President and have elected Col. F. H. FRIES General Manager. The line is graded from Winston to Walnut Cove, N. C., 18 miles, and 8 miles are in operation. Miller Bros., of Winston, have the contract for the depot at that place.

Covington & Macon.—The Richmond & Danville has bought about $100,000 worth of this company's bonds, and it is suggested that the line may yet form part of the Richmond & Danville system.

Norfolk & Western.—On the Clinch Valley extension, Samuel Walton, contractor for sections 22 to 25 inclusive and Sexton & Houston, contractors for sections 26 to 30 inclusive, have completed their work. Track is now laid to a point 10 miles west of Tazewell C. H. It is reported that the proposed Saltville branch will be built in the spring.

Winston & Wilkesboro.—This extension of the Richmond & Danville is under construction from Winston to Wilkesboro, up the Yadkin valley 125 miles. Track is now laid and trains are running for 20 miles west of Salem.

Georgia.—Surveys and estimates are to be made for double tracking 6 miles from Atlanta to Decatur, Ga.

Richmond & West Point Terminal.—W. B. RYDER has been appointed Superintendent of the Richmond & Danville divisions, with office at Richmond, Va. R. R. BRIDGERS has been appointed Superintendent of the North Carolina division, with office at Durham, N. C.

Kentucky Central.—C. P. HUNTINGTON recently stated to a reporter of the Cincinnati *Enquirer* that three different parties were negotiating for the purchase of this system, but that he was not at all anxious to sell, and might very likely keep the road. "This year," said he. "I intend to build several new branches which will greatly enhance its value." He also stated that the report, which has been so extensively published, that he has sold his interest in all railways east of the Mississippi, was news to him, as he had not disposed of his stock, nor did he intend to, at present.

Sheffield & Birmingham.—This road, now in the hands of a receiver, is to be known after reorganization as the Birmingham & Tennessee River R. R. Co. The failure of the road to earn its expenses and interest charges was due to the delay in starting the iron furnaces at Sheffield, whose raw material and product is expected to furnish it with a heavy traffic.

Georgia Southern & Florida.—Morgan & Reynolds, who graded this road from Tifton to Valdosta, Ga., have received the contract for grading the extension from Valdosta to Lake City, Fla., about 63 miles. Work will begin at once and is to be completed in four months.

Wadley.—The *Railway Age* says:

The lumber road running from Wadley, Ga., south toward Mt. Vernon is being extended to the latter place, a distance of about 50 miles, through Jefferson, Emanuel and Montgomery counties, and may be eventually extended to Waycross. William Donevan, of Wadley, Ga., is owner of the road.

Kansas City, Memphis & Birmingham.—According to the Chattanooga *Tradesman*, surveyors are at work on the proposed extension to some point on the Atlantic coast, and will complete their work by April 1.

Tennessee & Coosa.—It is reported that the Louisville & Nashville Company will complete this Alabama road.

Nashville & Knoxville.—It is stated that this company has made arrangements with the projectors of the proposed Nashville & Charleston road to continue the line to Knoxville and thence east across the mountains.

Kentucky Union.—It is announced that the bonds of this company to the amount of $12,000,000 have been taken by a syndicate headed by JOHN H. INMAN, which will furnish ample capital for the construction of the road. About 7,000 hands have been put at work on the grading.

Louisville, Cincinnati & Virginia.—DOUGLAS GREEN, who is prominently interested in this company, informs us that the enterprise has by no means been abandoned, but that construction is actively in progress.

Atlanta & Florida.—It is stated that HAMILTON DISSTON, of Philadelphia, has offered the company 1,000,000 acres of land. Besides this, offers of 65,000 acres of land have been made if the company will build from Fort Valley to Thomasville, Ga. The distance is about 125 miles, and from Thomasville to Tampa is about 300 miles.

Savannah, Americus & Montgomery.—Chief Engineer R. E. HARDAWAY, on March 2 awarded the contract for grading and tracklaying on the 25-mile extension from Abbeville to McRae, Ga., to McLaughlin Bros. Their headquarters while engaged in the work will be at McRae.

Richmond, Fredericksburg & Potomac.—Bids will be received until March 25 by Gen. Supt. E. T. D. MYERS for grading, masonry, and bridging on 8 miles of railway connecting this road with the Richmond & Petersburg near Richmond, Va. The work will include a high bridge across the rapids of the James river, the masonry and ironwork of which will be let separately. Specifications and plans can be seen at Superintendent MYERS's office, Richmond, Va., after March 15.

Projects and Surveys.

Chattanooga, Cleveland & Murphy.—E. WATKINS, of Chattanooga, President, has sent us the following information:

The surveys have been made for this road, which is projected to run from Cleveland, Tenn., via Benton and Hiawassee Gap to Murphy, N. C., a distance of 70 miles. The route is through a mountainous country; maximum grade 50 ft. per mile and maximum curve 6°. The principal business will be the transportation of iron ore, marble, talc, copper, and other minerals. About half the right of way has been secured and local aid to the amount of $125,000 obtained. Contracts for construction will be let about April 1, 1889. It is expected that tracklaying will begin about Sept. 1, 1889, and the road be opened for traffic by Jan. 1, 1891.

Weston & Elk River.—Incorporated in West Virginia to build a railway from Weston, Lewis county, to a point near Sutton, Braxton county. Among the incorporators are J. N. CAMDEN, of Parkersburg, and M. W. HANSON, JOHN BRANNON, N. B. NEWLON, and W. L. DUNNINGTON, all of Weston.

Cincinnati & Birmingham.—The contract for the construction of this road is said to be closed. The road is to be completed to Tullahoma, Tenn., by March 1, 1890 and to Woodbury, Tenn., by the following June.

Decatur & South Mountain Belt.—The officers of this company are: A. C. FREY, President; R. W. AUSTIN, General Manager; and T. G. MACKY, Chief Engineer, all of Decatur, Ala. The road will be 12 miles long. Construction is to commence within 60 days and the road will be completed in 12 months.

Rome & Guntersville.—It is reported that this road, which is projected to run from Rome, Ga., to Guntersville, Ala., about 63 miles, is to be built this season.

Hartsville.—It is stated that this company has made surveys for its 10-mile road and will build it during the coming summer. J. L. COKER, of Hartsville, S. C., is President.

Richmond Cedar Works.—A press report states that this company will build a line of railway to their timber lands near Greenville, Ala.

Paducah & Tennessee.—At a recent meeting the citizens of Paducah, Ky., voted a subscription of $100,000 to the stock of this road. The road is projected to run from Paducah, Ky., to Paris, Tenn., a distance of about 55 miles. THOS. H. PURYEAR, of Paducah, is President.

Fort Payne & Stevenson.—It is reported that there is a project on foot to build a line of railway from Fort Payne, Ala., to Stevenson, Ala., a distance of about 30 miles.

Atlanta, Athens, Kingston & Coal Fields.—It is stated that a company has been organized to build a road by this name from the State line in Polk county, Tenn., to Winter's Gap or the coal fields beyond.

Greenville & Southeastern.—A company is being organized at Greenville, Ala., to build a pole road from Greenville via Luverne to Andalusia, about 40 miles.

THE NORTHWEST—Existing Roads.

Illinois Central.—The annual report of this company shows unexpectedly favorable results from the operations of 1888; for though a falling off from the receipts of 1887 occurred, the reduction was not enough to wipe out the surplus after the payment of dividends during the year amounting to 6 per cent. The results of operations were as follows:

	1888	1887
Gross earnings	$11,822,477	$11,868,037
Net earnings	4,067,872	4,573,434
Surplus after paying dividends	163,537	436,357

The Chicago, Madison & Northern Railroad from a point near Chicago to Freeport, Madison, and Dodgeville, Wis., was completed and turned over to the company on Jan. 1, 1890.

The cost of this railroad surpassed the estimate, owing to the large outlay necessary to secure facilities at Rockford, the high price of land in and about Chicago, the requirements of municipal authorities with regard to crossings, and mistakes of engineers. While the cost may reach $40,000 a mile, that is less, it is claimed, than any other railroad has paid in 10 years for an independent entrance to Chicago. Valuable improvements were made on the line with last year's earnings, and not less than $600,000 will be expended this year.

No new extensions were undertaken in 1888, and none is in view.

Wabash.—The sale of the Chicago Division has been ordered to take place on March 11. The line will be bid in by the purchasing committee. The sale of the main line and other branches will probably be ordered by Judge GRESHAM at an early date.

Keokuk & Northwestern.—At the foreclosure sale of this Iowa road at Keokuk, March 1, the property was struck off to C. E. Perkins, President of the Chicago, Burlington & Quincy system.

Chicago & Northwestern.—The Junction Ry. has been chartered by officers of this company to build a line from Evanston southwest to Montrose on the Wisconsin division, about 6 miles. Surveyors are now locating the line.

Northern Pacific & Manitoba.—The company is applying for a charter for its lines from the Dominion Government.—It is reported that the company has made an agreement with the Canadian Pacific for the division of competitive traffic and the maintenance of rates thereon. The report greatly exercises the people of Manitoba, but is denied by Northern Pacific officials.

St. Paul, Minneapolis & Manitoba.—It is stated that the company intends to begin work on the extension from Sioux Falls to Yankton, Dak., as soon as the frost is out of the ground. A line is also projected to run from Jasper, Minn., 20 miles east of Sioux Falls, to Sioux City, Ia.

Northwestern Coal & Navigation Co.—A bill is before the Dominion Parliament authorizing this company to extend its road to the International boundary in the direction of Ft. Benton, Montana.

Winnipeg & Hudson Bay.—The Provincial Government of Manitoba has withdrawn the guarantee of 6 per

cent. interest for 25 years on bonds of this company to the amount of $4,500,000, and has substituted a cash bonus of $2,000 per mile on not more than 300 miles. This offer is to remain open till the next session of the Legislature. The new offer is so much less advantageous than the old that there seems to be no likelihood that the road will be built.

Projects and Surveys.

Marquette, Iron Range & Chicago.—Surveys are in progress for this road, which is projected to run from Marquette, Mich., to the iron mines, a distance of about 40 miles. It is stated that a contract has been made with nearly all of the mines which the road will reach to transport their entire product for 10 years. It is estimated that the road will cost fully $1,500,000. JOHN F. STEVENS is Chief Engineer.

Lake Manitoba.—A bill is before the Manitoba Legislature granting a charter to the Lake Manitoba Railway & Canal Co. to build a line of railway from Portage la Prairie to Lake Manitoba.

THE SOUTHWEST—Ex Roads

San Antonio & Aransas Pass.—The subsidy of $150,000 asked from the citizens of Llano and Gillespie counties in aid of an extension through those counties from Comfort to Fredericksburg, has been subscribed, and grading is to begin at once.

Cleveland, St. Louis & Kansas City.—Work on the Alton bridge has been stopped. Vice-President J. T. K. HAYWOOD states that the delay is only temporary and that work will soon be resumed. The company has applied to the city of Alton for a grant of land for terminal facilities.

Galveston & Western.—This Texas road is to be widened to standard gauge and relaid with steel rails. J. C LEAGUE is President.

Projects and Surveys.

St. Charles.—Incorporated in Arkansas with a capital stock of $100,000 to build a line of railway from St. Charles, Arkansas county, to Helena, Phillips county, about 30 miles. Among the incorporators are J. R. CAMPBELL, W. H. BRADFORD, G. W. SHINN, and J. H. MCCARTHY.

St. Joseph Belt.—H. D. L. FRENCH, of Philadelphia, STEPHEN S. SHARP, of Kansas City, and JAS. E. MCCOLGIN and others, of St. Joseph, Mo., have organized a company to build a railway from the stock-yards south of St. Joseph to the eastern city limits, and thence to a connection with the Union Street Railway in the northern city limits, a distance of 9 miles. The capital stock is $500,000.

Kentucky & Arkansas.—This company is reported to be at work on a railway from Arkansas City to a point opposite Baton Rouge, La., a distance of about 210 miles. W. B. DULTON, of Arkansas City, is interested.

Coleman & Albany.—It is said that the projectors of this road, which is to run from Coleman, Tex., to Albany, Tex., about 60 miles, have secured sufficient capital to build it.

Texas Midland.—There is a prospect that this old project will be revived as it is stated that certain parties are desirous of taking hold of the enterprise. The road was projected to run from Waco, Tex., to Shreveport, La., about 210 miles. Surveys and estimates were made, a greater part of the right of way was obtained, and subsidies were secured from many of the towns along the route. The line passes through rich pine timber land and the mineral region of Cherokee county. W. A. TAYLOR was President of the company.

Chicago, Hannibal & Springfield.—It is stated that certain English capitalists are willing to advance the money necessary for the construction of this road providing the original guarantees of right of way and bonuses, which have expired, will still hold good. The original project was to build a road from Springfield, Mo., to Hannibal, Mo., a distance of 235 miles, and it is proposed to extend it to Peoria, Ill., making the total distance about 350 miles. R. C. NICKERSON, of Chicago, is President.

Stockton, Hill City & Western.—A railway company by this name has been incorporated in Kansas. J. P. POMEROY is President.

Sulphur Springs & Cooper.—A press report states that G. B. BOOMER, of Rochester, N. Y., and T. H. STEWART, of Chicago, are contemplating the building of a narrow-gauge railway from Sulphur Springs, Tex., to Cooper, Tex., a distance of about 16 miles.

Winner Investment Co.—This company has filed papers petitioning the court to appoint commissioners to assess damages for those property owners who refused to sell them right of way for their proposed dummy line into Kansas City. The property owners claim that the company is not acting in good faith and that they propose to use the right of way obtained for a standard-gauge railroad. The company also holds a charter from Congress for a bridge at Kansas City across the Missouri river. It is understood that the Chicago & Northwestern and the Chicago, Rock Island & Pacific desire to come into the city in this way.

ROCKY MT. AND PAC.—Existing Roads.

San Diego, Cuyamaca & Eastern.—Tracklaying is making rapid progress on the 30-mile section from San Diego east, and the line is being located from the end of the grade, east to Dos Palmos, on the Southern Pacific, about 85 miles from San Diego. From this point it is said the road is to be continued to the Needles, at the point where the Atlantic & Pacific crosses the Colorado river, and it is supposed that a junction will be made at this point with the projected extension of the Utah Southern Railroad, a part of the Union Pacific system.

Union Pacific.—Engineer CHAS. HARLOWE is in charge of the corps which has begun work on a survey for the Carbon Cut-off railway, recently chartered in Wyoming. Another party, in charge of GEO. L. DILLMAN and P. EDQUIST, are at work on surveys from the terminus of the Cheyenne & Northern branch to Douglas, on the Fremont, Elkhorn & Missouri Valley R. R.—It is proposed to double track the Montana Union railroad.

Bellingham Bay Ry. & Nav. Co.—Considerable progress is being made on the grading for this Washington Territory road. Whatcom has raised $40,000 for the enterprise. Specifications for the bridge across the Nooksack river are nearly finished; and it is intended to have the road in operation from New Westminster to Bellingham Bay by September 1. Work has begun on the branch south from Mission, on the Canadian Pacific.

Spokane Falls & Northern.—D. C. CORBIN, who is to build this Washington Territory road, has engaged J. M. BUCKLEY, formerly General Manager of the Northern Pacific, to act as Superintendent of Construction. Surveyors are now at work on the line.

Astoria & South Coast.—J. R. O'NEIL is President of the Portland Macadamizing & Paving Co., which has the 10-mile contract mentioned last week. The Portland *Oregonian* says:

> It is safe to say that when that bridge is completed, and the first locomotive runs into Astoria with her whistle screeching and steam exuding from every pore, there will be such a celebration in the city by the seas as was never seen before.

Los Angeles & Pacific.—This road has just been opened for traffic from Los Angeles to Santa Monica Cal., 24 miles.

Projects and Surveys.

Tacoma & Lake City R. P. & Nav. Co.—Incorporated in Washington Territory, to build a railroad from Tacoma to American Lake, by FREEMAN CAMPBELL, F. C. ROSS, JAS. D SMITH, and others of Tacoma.

Port Townsend, Irondale & Hadlock.—J. A. KUHN, WM. PAYNE and others of Port Townsend, W. T., have chartered this company to build a motor road from that city to the head of the bay.

Denver & Salt Lake Short Line.—This company has been chartered in Colorado to build a railroad from Denver to Salt Lake City. W. A. H. LOVELAND, E. L. BERTHOUD, and others of Denver; MAURICE FLYNN, THEODORE MOSS, WM. H. BROWN and others of New York City are the incorporators.

Port Townsend Southern.—Surveys have begun on this Washington Territory road.

San Diego & Eastern Terminal.—Incorporated in California by W. A. CARLSON, THOS. HIGGINS, H. G. CHRISTIANSEN, and J. P. BURT.

Canadian & Western.—This company has asked a charter from the Government of British Columbia for a railway from a point at or near Bute Inlet to the Yellowhead Pass to connect with a proposed road from the east.

RAPID TRANSIT.

Cable Railways.—***Cleveland, O.***—The Cleveland City Cable Co. has been incorporated, with a capital stock of $100,000. It proposes to put a cable system on the Superior, St. Clair & Payne Ave. lines. FRANK ROBISON, T. H. BROOKS, and CHARLES HATHAWAY are interested.

Kansas City, Mo.—O. W. Meysenberg & Co., of St. Louis, Mo., have the contract for the yokes, track, and slot rail bolts for the Holmes St. line.

Dummy Lines.—***Anniston, Ala.***—The Anniston, Oxford & Choccolocco Valley Ry. Co. has been organized by E. LOCK and S. M. MILLIGAN, of Choccolocco, to build a dummy line from Anniston to White Plains, about 20 miles. Capital stock, $200,000.—The Anniston, Williamsport & Jacksonville Ry. Co. is to be chartered to build a dummy line to Jacksonville.

Birmingham, Ala.—F. SLOSS is interested in a new dummy line to Gate City.

Decatur, Ala.—The Decatur & South Mountain Belt & Dummy Line Co. has been organized to build a dummy line 12 miles long. Work will be commenced at once. President, A. C. FREY; General Manager, R. W. AUSTIN; Engineer, T. G. MACEY. Capital stock, $100,000.

Port Townsend, Wash. Ty.—A dummy line is being surveyed for T. J. DOOLEY. Engines have been ordered in Pittsburg, and cars in San Francisco. The line is to be finished in May.

Street Railways.—***Sunbury, Pa.***—Surveys are being made for a street railway to Northumberland.

Greensboro, N. C.—The Greensboro Street Ry. Co. wants to find a company to build the road in exchange for the bonds. Address J. W. GRIFFITHS.

Natchez, Miss.—The Natchez Street Ry. Co. wants bids for the construction and equipment of a line 2 miles long.

Jefferson, Ill.—The Jefferson Rapid Transit Railway & Electric Light Co. will build a street railway. Capital stock, $250,000. GEORGE C. THOMAS, GEO. H. PARKER, and S. S. KIMBALL.

Pullman, Ill.—The Pullman, South Chicago & Morgan Park Street Ry. Co. has received a franchise. Work is to be commenced this year.

Aspen, Col.—A street railway company has been organized and has asked for a franchise.

Oregon City, Ore.—Several street railway schemes for a line to Portland are on foot.

San Marcos, Tex.—A street railway is projected.

Electric Railways.—***Rochester, N. Y.***—The Thomson-Houston Electric Co. has been awarded a contract for the equipment of the electric railway from Rochester, N. Y., to Charlotte. The road is to be completed by June 1. There will be 16 cars, 8 of which will be closed and 8 open. The seats will face one way with an aisle in the center. Each car will be equipped with two 15 H. P. Thomson-Houston motors, and will be lighted by 5 electric lamps. The power station will be located near the N. Y. Central Ry. crossing, and will be equipped with two 100 H. P. engines and two 80 H. P. Thomson-Houston generators. The railway people state that the contract was awarded to the Thomson-Houston Co. because it was found that company would do the work in a thoroughly satisfactory manner, and that its apparatus would stand the severest tests to which it may be subjected. They made an especial point of its durability, and the minimum of repairs required by it. The contract was not given to the Thomson-Houston Co. till numbers of its roads had been inspected, and the railway people were thoroughly satisfied with the great excellence of the system.

Mount Desert, Me.—The Mount Desert & Eastern Shore Land Co. will build an electric railway 6 or 8 miles long.

Martha's Vineyard, Mass.—The street railway is to be operated by an overhead wire electric system.

Beverly, Mass.—The Beverly & Danvers Street Ry. Co. will have its cars operated on the storage system. The road is 3 miles long.

Parkersburg, W. Va.—The Park City Street Ry. Co. proposes to adopt an electric system; power to be furnished by the electric light plant.

Raleigh, N. C.—The street railway company proposes to adopt an electric system.

Americus, Ga.—A street railway 8 miles long is to be built by the New York Contract Co., and it will probably be operated by electricity.

CONTRACTING.

Tunnel.—A tunnel is to be built under the Calumet river at Hyde Park, Ill. It will be 250 ft. long with a shafts at each end 50 ft. deep.; tunnel and shafts to be 6 ft. diameter. Proposals will be received by A. V. POWELL, Superintendent of Public Works, until March 26.

Street Signs.—The following proposals for furnishing and placing street signs have been received by JOHN P. ADAMS, Commissioner of City Works, Brooklyn, N. Y.: Daniel McGlone, Class A, $4 per lamp complete. Chas. F. Taylor, Class B, 32 cts. per lamp for two sides or 64 cts. for 4 sides. John H. Matthews, Class B, 22 cts. per sign, 25 cts. per sign 2¾ x 15 ins. E. A. Dubey & Co., Class A, iron frame and brace, $1.84; four signs complete, $1; two signs complete, 79 cts; Class B, iron frames, 21 cts.; four signs, 38 cts.; two signs, 29 cts.; Class C, iron frame, $1.32; four signs, 33 cts.; two signs, 27 cts.

Ties, etc.—The Duluth Incline Ry. Co., of Duluth, Minn., has awarded contracts for timber to Fisher & Newton, of Duluth, at 23 cts. each for ties, 9 cts. each for posts, and 8 cts. per lin. ft. for telegraph poles. H. H. MYERS is General Manager of the railway company.

Railway Grading.—MR. CHAS. R. CHAPMAN, Chief Engineer of the Chicago, Kansas City & Texas Ry., at Kansas City, Mo., received 29 bids for grading 9½ miles of road, the work comprising about 200,000 cu. yds. The bids for embankment ran from 9 cts. to 15 cts. per cu. yd.; for earth excavation with 500 ft. haul, 13 cts. to 17 cts. per cu. yd.; solid rock, 60 to 95 cts. per cu. yd.; loose rock, 30 cts. to 55 cts.; haul after 500 ft., 1 ct. to 1½ cts. per yd. The contract was awarded to Creech, Lee & Kenefick.

Pier Work.—***Milwaukee, Wis.***—The following proposals for pier superstructure at Milwaukee harbor were opened Feb. 27, by Major CHAS. E. L. B. DAVIS, U. S. Engineer Office, Milwaukee, Wis.: W. T. Casgrain, Milwaukee, Wis., $7,283.20; C. H. Starke, Milwaukee, Wis., $7,519.10; Knapp & Gillen, Racine, Wis., $8,039.90; H. B. Herr & Co., Chicago, Ill., $8,288.30. The contract was awarded to W. T. Casgrain at the following prices: pine timber, $18 per 1,000 ft. B. M.; pine plank, $16; iron drift bolts, 3 cts. per lb.; iron screw bolts, nuts and washers 4 cts. per lb.; iron spikes, 4 cts. per lb.; oak timber in place, $45 per 1,000 ft. B. M.; oak piles driven and secured in the work, 30 cts. per lin. ft.; laying and securing plank in work, $5 per 1,000 ft. B. M.; framing, including all labor, $15 per 1,000 ft. B. M.; taking out and removing old protection piles, $5 per piece.

South Haven, Mich.—The following proposals for pier construction (cribs in place) were opened at Grand Rapids, Mich., Feb. 25, by Lieut. KUHN, U. S. Engineers: Wiemar, Rath & Gaylord, Ludington, Mich., $5,837.08; J. Munroe, Jr., Charlevoix, Mich., $6,093.98; E. E. Crosby, Muskegon, Mich., $6,293.02; Geer & Crawford, Saugatuck, Mich., $6,359.44; Knapp & Gillen, Racine, Wis., $6,717.23; Robert Finch, Grand Haven, Mich., $6,835.84; H. B. Herr & Co., Chicago, Ill., $7,068.27; Truman & Cooper, $7,214.96; W. E. Cook, Ludington, Mich., $7,347.15. The prices of the lowest bid were as follows: foundation and sheet piles, $1 and 40 cts. per lin. ft.; oak, hemlock, and pine timber, $40, $24, and $28 per M.; pine plank, $22 per M. iron screw bolts and straps, drift bolts, and spikes, 5½ 4, and 5 cts. per lb.; stone, $9.50 per cord; brush, $5 per cord; dredging, 80 cts. per cu. yd.

Pentwater, Mich.—The following proposals for pier construction (cribs in place) were opened at Grand Rapids, Mich., Feb. 25, by Lieut. KUHN, U. S Engineers: Wiemar, Rath & Gaylord, Ludington, $5,239.62; Truman & Cooper, Manitowoc, Wis., $5,333.90; John Munro, Jr., Charlevoix, Mich., $5,985.51; E. J. Crosby, Muskegon, Mich. $6,293.62; Knapp & Gillen, Racine, Wis., $6,070.33. R. Finch, Grand Haven, Mich., $6,740,63; W. E. Cook Ludington, Mich., $6,816.96. The prices of the lowest bid were as follows: foundation and sheet piles, $1 and 33 cts. per lin. ft.; oak, hemlock and pine timber, $35, $21 and $25 per M.; pine plank, $21 per M: screw bolts and straps, drift bolts and spikes, 5½, 4 and 5 cts. per lb; stone, $8.50 per cord: brush, $5 per cord; dredging, 65 cts. per cu. yd.

Castings, Etc.—The following proposals for supplies have been received by the Water Committee, Montreal, Canada:—For brass castings: T. L. Clark, 25 cts. per lb.; Garth & Co., 19 cts.; G. Lomer, 19½ cts.; Cuthbert & Sons 19 cts.; Canada Plating Company, 16¾ cts. for yellow brass, not called for by specifications; Guibord & Vincent, 20 cts.; E. Chanteloup, 19¾ cts.; R. Mitchell, 21½ cts, Contracts were awarded to Garth & Co. and Cuthbert & Sons for half the quantity each.—For brass tubing: T. L. Clark, 35 cts. per lb.; Lewis Bros., 32½ cts; R. Mitchell, 32½ cts.; B. J. Coghlin, 32¼ cts.; Garth & Co., 30½ cts.; E. Chanteloup, 31 3-5 cts. The contract was awarded to Garth & Co.—For hydrants: G. & F. Brown Mfg. Co. (Belleville), $87.75; John Macdougall, $72; Garth & Co. $70; J. Cridiford, $79.80; Guibord & Vincent, $78; E. Chanteloup, $80. The contract was awarded to Garth & Co.—For special castings: E. Chanteloup, $45 per ton; Alex. Mitchell, $46; John McDougall, $46; P. Amesse: $46.20. The contract was awarded to E. Chanteloup. B. D. MCCONNELL is Acting Superintendent of the Water-Works.

Street Work.—***Brooklyn, N. Y.***—The following proposals for flagging sidewalks have been received by JOHN P ADAMS, Commissioner of City Works: John Hart, 22 cts, and 22¼ cts. per sq. ft.; Henry Mogk, 21⅝ cts.; Dennis Norton, 21⅛ cts. The City Works Department will have Sackman St. and Fulton Ave. paved with granite blocks. The work will cost about $15,000 and $500,000 respectively.

Buffalo, N. Y.—The following proposals have been received by the city engineer, GEO. E. MANN. Repaving Elm St. with Medina sandstone: P. B. McNaughton $32,956; A. M. Holloway, $34,000; C. E. Williams, $34,045.—Repairing Clinton St. with Medina blocks, with concrete foundation and the fillings of the German Rock Asphalt & Cement Co.: C. E. Williams, $46,774; P. B. McNaughton, $48,900; A. M. Holloway, $49,900.—Repaving Washington St. with Medina sandstone: A. M. Holloway, $22,100; C. E. Williams, $22,935; P. B. McNaughton, $22,999.—Paving Hertel Ave.: P. B. McNaughton, $14,081.60; A. M. Holloway, $15,000; C. E. Williams, $15,150.—Paving So. Division St. and Delaware Ave. with Barber's Trinidad asphalt pavement: Barber Asphalt Paving Co., $8,044, $45,532.40.

Knoxville, Tenn.—Better pavements are desired, the business being too heavy for the macadam. It is proposed to have the principal business streets paved with Belgian blocks.

Terre Haute, Ind.—The court has granted a restraining order against the Wabash Ave. improvement, and has appointed a hearing for March 11. All bids received in answer to advertisements (in our columns) were returned unopened.

St. Paul, Minn.—Contracts have been awarded by the Board of Public Works as follows: Paving Marshall Ave. with pine blocks, James Forrestal, $29,350; paving Bates Ave. with cedar blocks, Claffey & Lee, $19,591; paving Mackubin St, with pine blocks, Louis E. Shipley, $17,000; sewering Hoffman Ave. and Clermont St., George J. Symonds, $8,075.

San Francisco, Cal.—Contracts have been awarded as follows: To B. McMahon & Sons, piling and capping the intersection of Bryant and Spear Sts., piles, $21,50 each; capping and planking, $26.50 per M. To E. Malley, regrading, etc., Erie St.; macadamizing, 4 cts.; curbing, $1; sidewalks, 15 cts. To John Hughes, constructing brick and pipe sewer in the crossing of Utah and Sonoma Sts.; brick sewer, $5.40; pipe sewer, $1.80; covers, $1.47; manhole, $30. To Gaitland & Donovan, constructing ironstone pipe sewer in Green St.: sewer, $1.70; manhole, $30. To Thomas Byrne, constructing ironstone pipe sewer in Devisadero St.: sewer, $1 63; manhole, $26.

Fort Scott, Kan.—Contracts have been awarded by the City Council as follows: Grading First St., A. J. Campbell, 27 cts. per cu. yd.; macadamizing Main St., Jno. Farnsworth, $1.05 per cu. yd. For macadamizing First St.; George Patterson, $1.06. The average price for macadamizing has been $1.15 to $1.25. This is for stone broken to 2 and 3 ins.

Baltimore, Md.—The Council has adopted a resolution requesting Mr. SMYRK, the City Commissioner, to furnish information as to the cost per square yard and the relative merits of the Hodgen block and other improved pavements as compared with Belgian blocks.

Augusta, Ga.—Washington St. is to be macadamized at a cost of about $10,000.

Kansas City, Mo.—The City Engineer has awarded contracts as follows: Grading Brooklyn Ave. W. Hickman, 14 cts. for excavation. Grading Central Ave., G. K. White: earth excavation, 16 cts.; rock excavation, 40 cts.; pipe, 35 cts. Grading North alley: John Casey, earth excavation, 15 cts.; rock excavation, 75 cts. Grading Summit St. 12th to 13th Sts.: earth embankment 9¾ cts., Smith & Bradbury. Grading Springfield Ave. James Armstrong: embankment, 16½ cts.; rubble masonry, $6 per cu. yd.; 18-in. pipe, 60 cts.; 15-in. pipe, 40 cts. Grading Springfield Ave., Charles McBride: embankment, 14 cts.; rock excavation, 20 cts.; 18-in. pipe, 55 cts.; 21-in. pipe, 90 cts. Grading Lexington Ave. P. W. McFarland: excavation, 11¾ cts.; 15-in. pipe, 45 cts.

Reservoir.—Director WAGNER, of the Department of Public Works, Philadelphia, Pa., has awarded to Filbert & Porter, at $1.52½ per sq. yd., the contract for lining with concrete the Western section of the East Park reservoir. This is the last and largest of the three, its area being 208,475 sq. yds. The work is to be completed by Nov. 15. It was estimated that the cost of lining the section would amount to $400,000, but the bid of Filbert & Porter is $39,000 below that figure. The other bidders were: R. A. Malone & Son, $1.83 per sq. yd., to complete the work by December 1; and W. H. H. Achuff, $1.97 per sq. yd., to be completed by Jan. 1. B. F. Shelmire received the contract for the brick pavement at $1.82 per sq. yd. and the Vulcanite Paving Co. the contract for asphalt walks, $2 per sq. yd., at the Lehigh reservoir.

Ditch Excavation.—The Grant Township Drainage District Commissioners, Vermillion Co., Ill., opened the following bids for 929 rods of open ditch on Jan. 29: GEORGE MCALLISTER, $2,399; WRIGHT & WALLACE, $2,440. The contract was awarded to GEORGE MCALLISTER. It amounted to a fraction over 9 cts. per cu. yd.

Rope.—The following proposals for Manila rope have been received by the Docks Commissioners, New York City: J. S. Barron & Co., 14.49 cts. per lb.; Alexander Polock, 14¾ cts.; Patterson Bros., 15 cts.; H. A. Rogers 15 cts.; Wm. Wall's Sons, 15 cts. (less 1½ per cent. for cash); J. F. Baxter, 15½ cts. The contract was awarded to J. S. Barron & Co.

Cement.—The following proposals for 500 bls. of Portland cement have been received by the Docks Commissioners, New York City: James Brand, $2.35 per bl.; E. W. Fisher, $2.45; Empire Warehouse Co., $2.45; A. C. Babson, $2.57; Eckmeyer & Co., $2.75. The contract was awarded to J. Brand.

Light Station.—The following proposals for the light station at the breakwater at Stonington, Conn., were opened Feb. 21 by Major D. P. HEAP, U. S. Lighthouse Engineer, Tomkinsville, N.Y.: T. H. Brooks & Co., Cleveland, O., $2,323; Springfield Iron Works, Springfield, Mass., $3,390; Allentown Rolling Mills, Allentown, Pa., $2,495; Builders' Iron Foundry, Providence, R. I., $2,500; Detrick & Harvey, Baltimore, Md., $3,722.75; Cheney & Hewlett, New York, $4,992.60; Jonson Foundry & Machine Co., New York, $6,987.50.

Broken Stone.—At Montreal the city pays $12 per toise for stone from the city quarry, though last year the price was only $9.35. The city also pays $5 per toise for breaking the stone, while the Harbor Commissioners pay only $4. There is considerable dissatisfaction with the contract system, and Mr. ST. GEORGE, the City Surveyor, is in favor of the city working its own quarry and being thus free of contractors altogether.

Dock Work.—At Buffalo, N. Y., the contracts for the docks and trestle of the Central Dock & Terminal Co. have been awarded to W. F. Wentz, of Moreland, N. Y. The work will cost about $300,000 and is for handling Reading and other shipments of coal. Work will begin as soon as the weather permits and is to be finished in one year.

At New York the Board of Dock Commissioners have awarded the contract for repairing the crib bulkhead at the foot of East 53d St. to B. J. Cronin, whose bid amounted to $2,440.

Dredging.—***New York, N. Y.***—The following bids for removing broken rock from Flood Rock, Hell Gate, were opened Feb. 14 by Lieut. Col. G. L. GILLESPIE, U. S. Engineer Office, New York: Atlantic Dredging Co., New York, $2.25 per gross ton for $100,000 worth of work, or $2.19 for $225,000 worth; Morris & Cummings Dredging Co., New York, $2.95 per gross ton for $225,000 worth of work.

Charleston, S. C.—The following proposals for dredging 400,000 cu. yds. between the jetties were opened Feb. 16, by Capt. FREDERIC V. ABBOT, U. S. Engineer Office, Charleston, S. C.: R. C. Howell, Atlantic Highlands, N. J., 17¼ cts. per cu. yd., $69,000; M. F. Brainard, New York, 23⅞ cts., $94,800; Morris & Cummings Dredging Co., New York. 35 cts., $140,000; Anson M. Bangs, Fayetteville, N. Y., 40 cts., $160,000; W. F. M. Cauley, Savannah, Ga., 43 cts., $172,000. The lowest bid was recommended for acceptance.

Brooklyn, N. J.—The following proposals for dredging in the Wallabout canal and basin have been received by JOHN P. ADAMS, Commissioner of City Works: W. H. Beard, work complete, $7,500; additional dredging, 24½ cts. per cu. yd. Henry E. DuBois, work complete, $6,975; additional dredging, 23 cts. per cu. yd.

PROPOSALS OPEN.

Water-Works.—Plans and specifications on file. C. W. GLEAVES, Mayor, Wytheville, Va.

Grading.—In New Utrecht. Plans and specifications on file. C. FURGUESON, Jr., 26 Court St., Brooklyn, N. Y. March 11.

Granite Blocks.—Furnishing 8,000 lin. ft. of granite curbing, and 9,000 sq. yds. of granite paving blocks: size of blocks 8 to 12 ins. long, 3½ to 4½ ins. wide, 7 to 8½ ins. deep. RICHARD SHEA, Chairman of Highway Committee, Holyoke, Mass. March 12.

Bridge.—Substructure and superstructure of swing bridge over the Chemung canal at Watkins, N. Y.: 50 cu. yds. excavation; 100 cu. yds. embankment; 150 cu. yds. masonry in abutments and pier, including coping; 17,900 ft. B. M. white oak per M.: 4,500 lin. ft. piles delivered; 4,000 lin. ft. piles driven; 1,000 lbs. wrought-iron; 100 lbs. cast-iron; 100 lbs. spikes and nails; removing old superstructure; removing and replacing iron railing; removing piles and timber work of old bridge; erecting temporary bridge and removing same. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. March 13.

Sewers and Paving.—THE BOARD OF PUBLIC IMPROVEMENTS, St Louis, Mo. March 14 and 18.

Pier Work.—Dumping board at foot of 38th St., East river. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. March 15.

Gas Well.—Depth not to exceed 1,000 ft. J. W. HANNAS, Secretary, Windsor Natural Gas, Oil & Mineral Water Co., Windsor, Ont., Canada. March 18.

Sewers.—Pipe, 900 ft. of 15-in., 7,800 ft, of 12-in., 1,200 ft. of 8-in., 800 ft. of 6-in.; 90 ft. of 12 x 8-in. branches; 2,250 ft. of 12 x 6-in. branches; 20 15-in. bends; 100 ft. of 8-in. curved pipe; 500 6-in. short bevel connections: 2,000 ft. of 8-in. invert blocks; 70 catch-basin flag stones 5 ft. x 5 ft. x 4 ins.; 80 pieces trap stones, 29 ins. x 10 ins. x 2 ins.; 40 sets of side catch-basin stones, 2 sets plain catch basin stones. JOHN A. COLEMAN, Commissioner of Public Works, Providence, R. I. March 20.

Pipe, Etc.—Pipe, fittings, etc., for water supply system at Boise barracks, Boise City, Idaho, J. G. C. LEE, Chief Quartermaster, U. S. A., Vancouver barracks, Wash. Ty. March 21.

Granite.—Granite stones for bulkhead or river wall. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. March 22.

Railway.—Grading, masonry and bridging of 8 miles of line, connecting the Richmond, Fredericksburg & Potomac and Richmond & Petersburg railways; including a high bridge across the rapids of the James river, the masonry and iron work of which will be let separately. E. T. D. MYERS, General Superintendent, Byrd St. station, Richmond, Va. March 25.

Jail.—DENNIS LEAHY, Secretary, Jail Commissioners, Knoxville, Tenn. March 25.

Dredging.—In Corsica creek, Md.; Fairlee creek, Md., and Broad creek, Del. W. S. SMITH, U. S. Engineer Office, Wilmington, Del. March 27.

Dry Dock.—At Kingston, Ont. Plans and specifications on file. A. GOBEIL, Secretary, Department of Public Works, Ottawa, Ont., Canada. March 28.

MANUFACTURING & TECHNICAL.

The Keuffel & Esser Co. has been organized to carry on the business of Messrs. Keuffel & Esser, Fulton St. New York; dealers in all kinds of engineers', architects' and draughtsmens' instruments and materials.

Filters.—The National Water Purifying Co., of New York, reports numerous orders from the American Water-Works & Guarantee Co. for filters for water-works being built by the latter company.

The Standard Car Coupler & Buffer Co. has been organized at East St. Louis, Ill., by J. O'GRADY, L. B. KEGLER, and I. C. HUBBELL. Capital stock, $750,000.

The American Street Lighting Co. has been organized at Chicago, Ill., by L. O. GILLILAND, E. W. COOK, and H. KEELER. Capital stock, $300,000.

Machine Tools.—Manning, Maxwell & Moore, of New York, have an order for 214 21-in. lathes for the Westinghouse Air Brake Co., of Pittsburg.

The Bethlehem Iron Co., of Bethlehem, Pa., has voted to increase its capital stock from $2,000,000 to $3,000,000.

Shops and Transfer Table.—Adams & Schneider, of Chattanooga, Tenn., have the contract for shops and a transfer table at Birmingham, Ala., for the Alabama Great Southern Ry. The contract price is $20,000.

Gas Well.—The Wheeling Natural Gas Co., of Wheeling, W. Va., has purchased 1,000 acres of land and will sink a well very soon.

Dump Cars.—The special feature of the new dump car brought out by C. W. Raymond & Co., of Dayton, O., is the dumping attachment. The greater part of the weight of the load being on the dumping side of the trunnions, the touch of a lever causes the body of the car to tip, and when the load is discharged the dead weight of the body is on the other side of the trunnions, causing it to return to its normal position, locking itself in that position and automatically fastening the end door. End and side dump cars are made.

Cars.—J. G. Brill & Co., of Philadelphia, Pa., have the contract for the cable cars for the Olive St. line of the Missouri Ry. Co., at St. Louis, Mo.

The Barney & Smith Mfg. Co. has an order for 3 parlor 6 passenger and 4 baggage cars for the Eastern Minnesota, and another for 4 passenger and 2 baggage cars for the Chicago, St. Paul & Kansas.

The Terre Haute Car Works, of Terre Haute, Ind., are turning out 8 cars a day for an order of 250 for the Cleveland, Columbus, Cincinnati & Indianapolis.

The Indianapolis Car Works, of Indianapolis, Ind., have recently completed a large order for the Chicago, Burlington & Quincy.

The San Antonio & Aransas Pass Ry. Co. has ordered 500 stock cars.

Railway Material.—The Oliver Coal Co., of Oliver Springs, Tenn., wants a hoisting engine, drum and cable for operating cars in a new tunnel. Address Jos. RICHARDS, General Manager.

The Hamilton Railway & Lumber Co., of Hamilton, N. C., will build a lumber line about 8 miles long.

Pierce & Torrey, of Orlando, Fla., want rolling stock for a railway now under construction.

The Natchez Street Railway Co., of Natchez, Miss., wants proposals for the construction and equipment of its line; 2 miles long.

The Chicago Architectural Iron Works Co. has been incorporated at Chicago, Ill., by H. H. MEISELBAR, M. SALOMON and E. J. WALSH. Capital stock, $26,000.

Machinery.—Pierce & Thomas, of New York, have recently received an order from the Edison Electric Co., for a 150 H. P. mill for concentrating iron ore, to work with the company's electric concentrator, the first large plant erected in this county; also an order for a cement mill with a 300 H. P. Corliss engine and 3 boilers, etc., and another for a 250 H. P. double compound condensing Corliss engine. The firm has also an order for an electric light plant of 100 H. P. at Bogota, U. S. Colombia.

Drop Forgings of iron and steel, for all classes of work are made by J. H. Williams & Co., of Brooklyn, N. Y.

The Decatur Iron Bridge & Construction Co.'s works, which were sold at auction recently, were bought in by T. M. SCRUGGS, Secretary of the Mineral Land Co., for the Exchange and First National Banks, for $23,000.

Street Railway Motors.—The Knoxville Improved Street Car Co., of Knoxville, Tenn., has leased to IRA C. C. RINEHART, of Chicago, Ill., the right to manufacture and introduce the motor invented by Mr. H. K. SANS, president of the Knoxville company.

The Roberts Motor Co. has been organized at Baltimore, Md., by THOS. ROBERTS and others, with a capital stock of $340,000, to manufacture improvements in street railway locomotives.

Flagging.—Prices of sidewalk flagging are wanted by JOSEPH MARZYCK, of Jacksonville, Fla.

Portable Buildings.—The Ducker Portable House Co., of New York, has issued an illustrated pamphlet describing the different uses to which its portable buildings can be put for camps, summer cottages, bath and boat houses, etc. Illustrations are given of a portable hospital at the Wellington Barracks, London, England: it is 18 x 34 ft., weighs 3,900 lbs. and cost $3,000. These buildings are of wood, covered with indurated fibre, are made in sections, and are put together without any nails or screws. For transportation the sections are folded together. These houses are said to have been used in Europe and the British colonies.

Rock Breakers.—The Gates Iron Works, Chicago, have just furnished for Messrs. Carnegie, Phipps & Co. one of their No. 8 rock breakers. This machine is the largest rock and ore breaker ever built, weighs 45 tons, and will break any kind of rock at the rate of from 2 to 3 tons per minute. The breaker will be used at the Edgar Thompson steel works, for breaking flux for the furnaces. The Cambria Iron Co., of Johnstown, Pa., and the Birmingham Mining & Milling Co., of Birmingham, Ala., are also using breakers for the same purpose. The Gates No. 8 breaker will receive a stone 18 x 45 ins. in size, having three receiving openings of those dimensions; 2,500 tons of flux have been broken by this machine in 10 hours' work. The firm have recently sent several of their rock and ore breakers to the Argentine Republic for use in the mines. They have also shipped others to New Zealand, France, England, and Australia, some for mining work, others for railway and street work.

Locomotives.—The Brooks Locomotive Works, of Dunkirk, N. Y., have delivered 2 freight engines to the Cincinnati, Wabash & Michigan.

The Schenectady Locomotive Works, of Schenectady N. Y., are building 6 passenger engines for the New York Central & Hudson River.——The engines being built for the Cleveland, Columbus, Cincinnati & Indianapolis are to haul the heavy passenger trains on the Columbus & Cincinnati division. Cylinders, 18 x 24 ins.; drivers, 5 ft. diameter; boilers, 54 ins. diameter; weight, 98,000 lbs. with 63,000 lbs. on the drivers; the tender contains 30,000 gals. of water and weighs 63,000 lbs.

The Rogers Locomotive Works, of Paterson, N. J., have delivered 2 engines to the Louisville & Nashville. Cylinders, 21 x 24 ins.

The Baldwin Locomotive Works, of Philadelphia, Pa., have completed 2 switch engines for the Lehigh Valley.

The Pittsburg Locomotive Co., of Pittsburg, Pa., will enlarge its works and increase the capacity to 250 or 300 engines a year; 96 engines were built and 14 rebuilt during 1888. They have finished 3 engines for the Vandalia line.

The Louisville & Nashville will build 4 passenger engines at its shops.

The New York Central & Hudson River has put 8 new engines on the Rochester division.

Wire Rope.—Mr. J. F. BEARD, of Nuevo Leon, Mexico, wants 700 or 800 ft. of ¾-in. wire rope; galvanized preferred.

Oil Wells.—T. H. W. JAMES, of Charlotte, Tenn., will have wells drilled near Dickson to search for oil.——The Kentucky Oil Co., of Somerset, Ky., will soon commence drilling for oil and gas.

Concrete Buildings.—The great hotels—the Ponce de Leon, the Alcazar, and the Cordova—at St. Augustine, Fla., are built of monolithic concrete, composed of a mixture of broken shells ("coquina") and Portland cement, in the proportion of 6 parts of shell to 1 of cement, the walls being carried up in courses 6 ins. thick, so that there are practically no joints in the whole structure. It is not exact to say these hotels were built: they were cast. Over 50,000 barrels of Portland cement were used in the construction of the Ponce de Leon alone, and this cement was supplied by Baetjer & Meyerstein, of New York City, importers of the Hanover Portland cement. The same firm has supplied altogether over 100,000 barrels of its cement for these hotels, concrete buildings, and the various artificial stone structures at St. Augustine, Fla.

BRIDGES AND CANALS.

Calumet River.—The survey of the Calumet river, Illinois, has been completed and the work of widening and deepening the channel from the mouth of the river to Calumet lake will shortly be under way. District Attorney EWING, acting under orders from Washington, has for over three years been engaged in perfecting the survey, examining riparian titles, and obtaining deeds. Congress made two appropriations for the work, the first in 1884 and another in 1886. The title to a vast amount of territory has been deeded to the Government. The course of the river, which is at present crooked, will be straightened, the channel widened to 300 ft., and given a uniform depth.

Baltimore Harbor.—The Harbor Board of Baltimore, Md., has issued its report for the year ending Dec. 31, 1888. The appropriations aggregated $79,786.77, and $87,288.50 is asked for work during the present year. Details are given of the various works carried out. The report of the engineer, Mr. N. H. HUTTON, gives the cost of the various works with a list of bids received for dredging, etc. Contracts for dredging were let in June to L. J. Fobes at 14, 15, and 19 cts. per cu. yd. for different localities; the gross cost of dredging, including supervision, office expenses, use of tug, surveys, etc., was 21.77 cts. per cu. yd. A contract for new wall in city dock was also let in June to Ross & Sanford: $400 per 100 ft. for excavating, grading, paving, etc.; $3.50 and $6.50 for yellow pine and oak piles driven and cut off; $25 per M. for timber, 3¾ cts. per lb. for iron, $6 per cu. yd. for masonry, $2.50 lin. ft. for coping.

Viaducts.—*Argentine, Kan.*—The engineers of the Kansas City Bridge & Iron Co. have been making a survey for the proposed viaduct crossing the Santa Fé tracks near the depot. The bridge company will prepare plans and specifications for the viaduct and submit them to the railway officials for consideration. The company will no doubt construct the viaduct this summer.

Chicago, Ill.—Corporation Counsel Green has drawn up contracts between the city and the Milwaukee & St. Paul Railway defining the liabilities of each in regard to the Ashland Ave. viaducts. The city has agreed to raise the houses fronting on the raised section to the street level.

Kansas City, Mo.—The Wrought Iron Bridge Co., through Mr. J. W. HOOVER, its agent, has made a proposition for a new contract for the construction of the superstructure of the 4th St. viaduct under the new plans made necessary to meet the requirements of the Hannibal & St. Joseph and the Missouri Pacific railway companies. The changes in said construction provided for in this contract will increase the cost of the viaduct about $12,678.82. The original contract amount was $23,400.

Toronto, Ont.—The Hamilton Bridge & Tool Co. has nearly completed the construction of the steel viaduct over the Don at North Toronto, for the Canadian Pacific Railway. It is about 1,200 ft. long. There are 17 plate girder spans of 30 ft. each, 12 spans of 45 ft. each, and one lattice girder 100 ft. long. The height from the water is about 75 ft., and the bents start from piers of masonry 4 ft. square. It is a deck structure, 10 ft. wide. The total weight is 1,514,585 lbs. The work will be completed about the middle of March.

Bridge Notes.—*Lewiston, N. Y.*—It is reported that the Canadian Pacific Ry. Co. will build a bridge across the Niagara river.

Verona, Pa.—The Verona Bridge Co. has been incorporated by H. BERG, D. F. MCINTOSH, J. H. MOORE and others, to build a bridge across the Allegheny river. Capital stock, $100,000.

Philadelphia, Pa.—The Council has passed the bill to authorize the construction of the 34th St. bridge. It provides that the structure be a plate girder deck bridge 70 ft. wide; three spans 76 ft. 2 ins. each, and one span 37 ft. over the Junction Ry.; the substructure to be made of iron plate girders and floor beams of sufficient strength to carry iron buckled plates and two tracks for a horse railroad, with stone block and asphalt pavement, the present bridge to be built with plank flooring between curbs and the railing to be of iron. It provides further that all the cost over $40,000 shall be paid by the Pennsylvania Railroad Co. The cost will be about $100,000.

Pittsburg, Pa.—Contracts have been let for the construction of the connecting railway bridge across the Ohio river at Brunot's Island, below this city. It will connect the lines of the Pittsburg, Cincinnati & St. Louis and the Pittsburg, Fort Wayne & Chicago roads. The structure will be a mile long, will take a year to build, and will cost $600,000. It will consist of 13 deck spans, 2 channel spans, 3 spans crossing other tracks, and 1 iron viaduct 700 ft. long.

Harrisburg, Pa.—A bridge over the Susquehanna river is projected.

Baltimore, Md.—A new bridge will be built at Light St. For particulars address Mr. A. E. SMYRK, City Commissioner.

Wheeling, W. Va.—The Main St. bridge, built by the Wrought-Iron Bridge Co., of Canton, O., has been accepted by the city. The 17th St. bridge has been reported to be in a dangerous condition.

Elkton, Tenn.—The contract for an iron bridge has been let to the King Iron Bridge & Mfg. Co., of Cleveland, O., at $7,000.

Chattanooga, Tenn.—The Chattanooga Land, Coal, Iron & Ry. Co. will build an iron bridge across the Tennessee.

Florence, Ala.—The contract for the railway bridge across the Tennessee has been awarded to McDonald, Shea & Co., of Knoxville, Tenn.

St. Louis, Mo.—The plans for the 21st St. bridge over the railway tracks have been approved. The structure will be about 1,500 ft. long, including approaches, each of which will be 200 ft. in length, and built of stone. The total width of the bridge will be 50 ft., the roadway 32 ft., and the footways each 8 ft. The superstructure will consist of a number of short iron spans, with three spans over the tracks. The estimated cost of the structure, exclusive of land for the approaches, will be $175,000. The street will be widened to about 100 ft. for the approaches.

Kansas City, Mo.—The bill for a bridge at Bonner Springs has passed both houses of the Legislature.

The Baltimore & Ohio will replace the wooden bridges on its Wheeling division with iron ones during the summer.

The Pennsylvania will rebuild all its short span bridges with brick or stone arches.

Stone Arch Bridge.—The following proposals for building a stone arch bridge at Roger Williams park have been received at Providence, R. I.: F. E. Shaw: 272 spruce piles at $4.50; 10,560 ft. B. M. of spruce lumber at $30; $18,400 for balance of work; total, $19,940.80. New Hampshire granite.——Kenneth McKay: $9 for piles, $35 for lumber, $18,876.30 for balance, $21,609.90 total. Westerly granite.——John T. Tank: $8 for piles, $35 for lumber, $20,700 for balance, $23,245.60 total.——D. H. Cram: $8.90 for piles, $45 for lumber, $21,010 for balance, $23,906 total.——Ingerson, Nash & Snow: $7.50 for piles, $40 for lumber; $23,580 for balance, with Monson granite; $23,026 with Oneco granite; $22,608 with Oakland granite; totals, $26,042.40, $25,488.40, $25,070.40. All the bids were rejected.

Canadian Canals.—Mr. THOMAS MONRO, of St. Catharine's, Ont., is at Coteau Landing, Que., engaged in preparing a report advising the Government on the question of the location of the enlarged canal between Lake St. Francis and Lake St. Louis. Some persons think it will be better to enlarge the existing Beauharnois canal, while others think an entirely new canal should be built on the north shore of the St. Lawrence. Mr. MONRO has had charge of the construction of the new part of the Welland canal during the past 18 years; this work is now completed to a 14-ft. depth, and when this is established between Lake Erie and Montreal, it is hoped that the Ca-

nadian canals will get their share of the carrying trade of the West.

ELECTRICAL.

Electric Power and Light.—Mr. FRANK F. DOWNES, of Chicago, representing the Sprague Electric Railway & Motor Co., is seeking to form a company at Denver, Col., to purchase a site near the center of the manufacturing district of the city and construct a five or six story building, 50 by 125 ft. It is planned to place in the basement of this structure a steam power of about 700 H. P., an electric power and light dynamo plant, and to fill the rest of the building with manufacturing industries, the machinery of which would be driven by electric motors. It is planned, in addition to the operation of these factories, to supply power to any manufactory within a radius of 1½ miles. It is also designed to furnish electric light power for incandescent systems. The cost of the building and plant would reach $250,000.

Electric Light.—*Windsor Locks, Conn.*—The Windsor Locks Electric Lighting Co. is receiving propositions for putting in a plant.

Dansville, N. Y.—The contract for the lighting of the village by electricity has been signed by the board of trustees, the amount being $1,982. The superintendent has a force of men now at work setting the poles. Within two or three weeks a 45-arc light dynamo will be placed in the works, and the lights will be in operation by April.

Burlington, N. J.—The contract for lighting the streets by electricity has been signed.

Bowling Green, O.—The City Council will advertise for bids for electric lighting.

Louisville, Ky.—The Louisville Gas Co. proposes to issue $250,000 bonds for a plant for electric light and power.

Nashville, Tenn.—The Capital Electric Co. has been organized to put in a Thomson-Houston plant; there will be 100 to 300 lights for a term of 3 to 5 years. ADOLPH DAHLGREN, T. A. ATCHISON, and J. H. AMBROSE are interested.

Goldsboro, N. C.—An electric light plant is to be put in by O. H. FOSTER, of Raleigh.

La Grange, Ga.—The La Grange Cotton Mill Co. is interested in an electric light project. For particulars address J. D. EDMONDSON.

Thomasville, Ga.—A franchise has been granted to an electric light company organized by J. W. REID, of Thomasville, and New York parties. A Thomson-Houston plant will be put in.

Savannah, Ga.—The Oglethorpe Electric Co. has been organized by H. C. HOUSTON, J. R. YOUNG, J. P. WILLIAMS and others.

New Decatur, Ala.—The city council is proposing to put in an electric light plant.

Detroit, Mich.—The city has decided to put in a large electric light plant of its own, at a cost of about $400,000.

Bloomington, Ill.—The Bloomington Electric Light Co. will put in a Thomson-Houston plant.

Searcy, Ark.—For particulars as to the projected electric light system, address M. G. PETTY.

San Marcos, Tex.—The city intends to put in an electric light plant. For particulars address Mr. H. HARDY, mayor.

Bogota, U. S. Colombia.—The new Bogota Electric Light Co., of New York, is reported to be backed by PEREZ TRIONA & Co., of 16 Beaver St., New York.

WATER AND MUNICIPAL.

Irrigation.—*Kansas.*—The Sherlock Irrigating Ditch Co. has been organized by N. F. WEEKS, J. W. GREGORY, and J. HOFFMAN, of Garden City; and W. DRUMMOND, of Sherlock.

Nebraska.—At Gottenburg it has been voted to issue $5,000 in aid of a canal.

Colorado.—The canal and lands of the Del Norte Land & Canal Co. have been sold under foreclosure to S. C. DUNHAM, of Hartford, Conn., for $100,000. A new company will be organized to operate this canal, which is said to be the largest in the State.

Idaho.—It is proposed to build a canal to take water to irrigate several thousand acres of land in the Shoshone valley.

Montana.—An irrigation company, with ex-Gov. HAUSER at its head, is building a canal in the north part of the State from Sun river, which will irrigate about 3,000,000 acres of land between the Teton and Missouri rivers and Sun river and Renton. The capital stock is $750,000. The company has expended over $200,000 and built about 200 miles of ditch, and tapped Benton lake, at an expense of $40,000. Over 100 miles of small and large ditches have been constructed from Benton lake, upon which more than $100,000 has been expended during the past season.

California.—At Traver, the Alta Irrigation District has voted to issue bonds for $75,000. The district comprises a portion of Tulare and Fresno counties.——J. D. Hooker & Co., of Los Angeles, have the contract to furnish water pipe for the new irrigation mains of the Pasadena, Lake Vineyard, Land & Water Co.

Artesian Wells.—*Warsaw, N. Y.*—The town has voted for an appropriation of $300 for an artesian well.

Albany, N. Y.—The public test of the new system of gang wells will probably be commenced about March 15.

Wytheville, Va.—The Southwest Virginia Enterprise Co. proposes to have artesian wells put down.

Americus, Ga.—J. S. D. Shipp will let contracts for the sinking of a well.

Barnwell, S. C.—The well is down 800 ft. and still in quicksand; it was expected that water would have been struck at a less depth.

Charleston, S. C.—The new artesian well flows 600 galls. per minute and is to be put down to a depth of 2,000 ft. Mr. ZIMMERMAN DAVIS is Superintendent of Water-Works.

What Cheer, Ia.—The well is said to have reached a depth of 1,200 ft. without securing a good flow of water; and the city has let a contract to put it down 400 ft. more. The well has shown three veins of coal under the city.

Pueblo, Col.—The well north of the town is 1,500 ft. deep and water is expected to be met with very soon.

Farmington, Wash. Ty.—The well at the Oregon Ry. & Navigation Co.'s shops has been completed. Water was struck at a depth of 80 ft.

Ogden, Utah.—It is suggested that artesian wells may be utilized for furnishing water for the city. It is feared that artesian water will prove so strongly mineralized that its use in its natural state will be impossible; but the suggestion is made to turn the flow from one or more such wells into the city reservoir, where it can mix with mountain water and become palatable.

Laredo, Tex.—The Laredo Improvement Co. will put down an artesian well.

Panhandle City, Tex.—The Cook Well Co., of St. Louis, Mo., has a contract to put down a system of tube wells to supply water to the city and railway. The railway company put a well down 350 ft. without striking water.

Deloraine, Ont.—The town well is down 650 ft., but is not yet finished.

Gas Works.—*Brooklyn, N. Y.*—At present the Fulton Municipal Gas Co. supplies all the other companies with gas manufactured by its patent process, and the local companies simply let it flow through their mains. Some time ago a party of capitalists offered a new patent to the Fulton Company, but the price demanded, about $500,000, put an end to negotiations. Then the syndicate set to work to buy a controlling interest in the Citizens' Gaslight Co., one of the locals supplied by the Fulton Company, and have succeeded in doing so. Work on the new plant will soon begin.

Cartersville, Ga.—The Orient Electric Gas & Water Co., of Boston, Mass., is putting in gas works. There will be a holder 33 ft. by 12 ft., and 60 street lamps.

Hyde Park, Ill.—Application has been made by Hawk & McCleary for the right to supply the village with oil and gas for heating and illuminating purposes. The firm proposes to supply gas for illuminating purposes at a rate of $1.20 per 1,000 ft., with a rebate of 20 cts., and for heating purposes at a price of 90 cts. per 1,000, with a rebate of 20 per cent. The company will put up a bond of $20,000, and will erect works with a capacity of 250,000 ft. a day.

Fort Scott, Kan.—The following proposals have been received by the Council: Fort Scott Light & Fuel Co.: $1.50 per 1,000 cu. ft. of gas, for lighting, and $1 per 1,000 ft. for fuel, and to furnish 125 lamps in the west and southwest part of the city at $18 per lamp. Fort Scott City Gas Co.: 256 lights (present number), or up to 300 or more street lamps, at $18 per lamp of 20 c. p., and will extend mains where wanted.

Wilmington, Del.—The Chief Engineer of the Water Department, Mr. JOSEPH A. BOND, has issued his report for 1888. The periodical trouble with a plant growth in the water supply was experienced. At the Cool Spring pumping station a water-power plant, designed by Mr. A. FELDPAUCHE, of the P. W. & B. R. R., was put in by Robert Wetherill & Co., of Chester, Pa.; it consists of a wheel 22 ft. diameter and 14 ft. breast, geared to two 14 x 18 duplex pumps. The pumpage for the year was 1,959,361,847 galls. These 8,336 ft. of low-service and 1,687 ft. of high-service distribution pipe laid and 2 hydrants set. There are now 71.34 miles of pipe and 627 hydrants.

Ottawa, Ont.—The Water-Works Committee has issued its report for the year ending Oct. 31, 1888. The contract for a new set of pumps on the design furnished by Mr. JOHN KENNEDY was let to the Canadian Locomotive & Engine Co., of Kingston, Ont., for $35,000. The total pumpage for the year was 1,550,087 galls. During the year there were 4.90 miles of pipe laid and 21 hydrants set. At the date of the report there were 63.642 miles of pipe, 526 stop valves, and 434 hydrants. Mr. ROBERT SURTEES is Manager of the works.

Water-Works.—*Connecticut.*—Windsor Locks. The city has voted to exempt the water company from taxation. Pipe-laying to the pond will be commenced at once, and water is to be supplied by Sept. 1.——Manchester. The contract with the new company was discussed at a town meeting on Monday, and was referred to a committee, which will report on March 12. Pipes are to be laid from a reservoir and there are to be 30 hydrants for a rental of $900 per annum for 20 years; additional hydrants at $30 each.

New York.—Long Island City. A bill is to be presented to the Legislature to authorize the issue of bonds to pay for an additional water supply. The amount will probably be about $100,000.——Green Island. A tank is to be put in, to furnish a supply at night, so that the pumps can be stopped.——Tarrytown. The present supply from an artesian well is insufficient. The Pocantico Water Co., which supplies North Tarrytown, Hastings, and Dobbs Ferry, has offered to furnish a supply.——Brooklyn. The aldermen are said to be trying to delay the work for the new water supply, none of the Water Committee having yet looked at the plans, although they adjourned a few weeks ago for this purpose. The inhabitants of Suffolk county are opposed to the scheme.——Rochester. Surveys are being made by GEO. W. RAFTER for the conduit line for Hemlock water, according to the recommendations of the experts.——Buffalo. The water supply is said to be insufficient.——Clyde. A consignment of water pipe has been received.

Pennsylvania.—Pittsburg. An appropriation of $75,000 has been made for a distributing main from the Hiland reservoir to supply the district around Oakland. It would cost $200,000 to connect this reservoir with the city; this must be done soon, but not this year.——Punxsutawney. Some of the suburban citizens objected to paying water taxes when they did not get a water supply, and an election was held to decide whether the city should pay for water, the rental being $15 per hydrant for fire purposes. The vote was 313 in favor of a water supply and 101 against.

Virginia.—Wytheville. Proposals are being invited for building the water-works. Plans and specifications can be obtained from Mr. C. W. GLEAVES.

North Carolina.—Goldsboro. The Goldsboro Water Co. has been organized. Capital stock, $100,000.

Louisiana.—Shreveport. The city and some of the consumers have refused to pay the water rates on account of the condition of the water; the company will probably put in a filter plant.

Tennessee.—Maryville. Mr. STEPHEN POST is President of the new water company.——Tullahoma. The Nashville, Chattanooga & St. Louis Ry. Co. will establish a pumping station and will probably supply the town with water.

Kentucky.—Russellville. Water-works are projected and the matter is being discussed by the Council.——Owensboro. The Owensboro Water Co. has called for redemption all the outstanding first mortgage bonds of October, 1878.

Ohio.—Cleveland. The Water-Works Board had a test made recently of the new pumping engines built by the Knowles Steam Pump Co. The specifications called for a capacity of 15,000,000 galls. per day, but the test showed a capacity of 16,000,000 galls.; the water is raised 27 ft. The engines cost $79,000.

Michigan.—Northville. Mr. MCWALKER, of Fenton, has made a proposition to put in water-works. The supply would be obtained from wells, and there would be 34 hydrants. Cost, from $21,500 to $25,000.——Monroe. The city has awarded the water-works contract to W. S. Parker & Co., of Pontiac. The city to pay $6,000 annual rental, or to buy the works for $120,000. The supply is to be taken from Lake Erie and the works will be completed by September.——Mt. Clemens. A test of the new works has been made.

Illinois.—Peoria. The Hegeman & Oliphant Filter Co., of New York, proposes to put in a plant for the water-works, and has a representative in the city.——Lake View. There is considerable complaint over the quality of the water supply.

Iowa.—Council Bluffs. The water company is blamed for the foul condition of the water, as the reservoirs are said to be in a dirty state.

Minnesota.—Minneapolis. The contract made with the Addyston Pipe & Steel Co. has been cut down from $121,000 to $60,000.

Kansas.—Argentine. A water company will make a proposition to supply the city with water for domestic and fire purposes.——Horton. The town has contracted to have water-works.

Nebraska.—Republican City. A contract has been let for building water-works; work is to be commenced at once.——Aurora. The water-works are approaching completion.

Wyoming.—Douglas. The city has decided to put in a system of water-works. A reservoir of 100,000 galls. capacity will be built.

Texas.—Caldwell. The Business Men's Exchange is agitating for the establishment of water-works.

Colorado.—Holyoke. A water supply company has been organized.——Colorado Springs. Surveys are being made for the new water-works.

Oregon.—Portland. The Water Committee has 8 of the 20 miles of new mains laid, and will have all laid by June. The new pump is working satisfactorily.

Canada.—Brantford, Ont. The city is inviting proposals for $185,000 of water-works debentures; they will be received until March 27. For particulars address Mr. JAMES WILKES, City Treasurer.——Victoria, B. C. The report of the Water Commissioner, Mr. PETER SUMMERFIELD, for 1888, shows that 110 services were added, making a total of 1,738, only 29 of which are metered; 39 new hydrants were set.